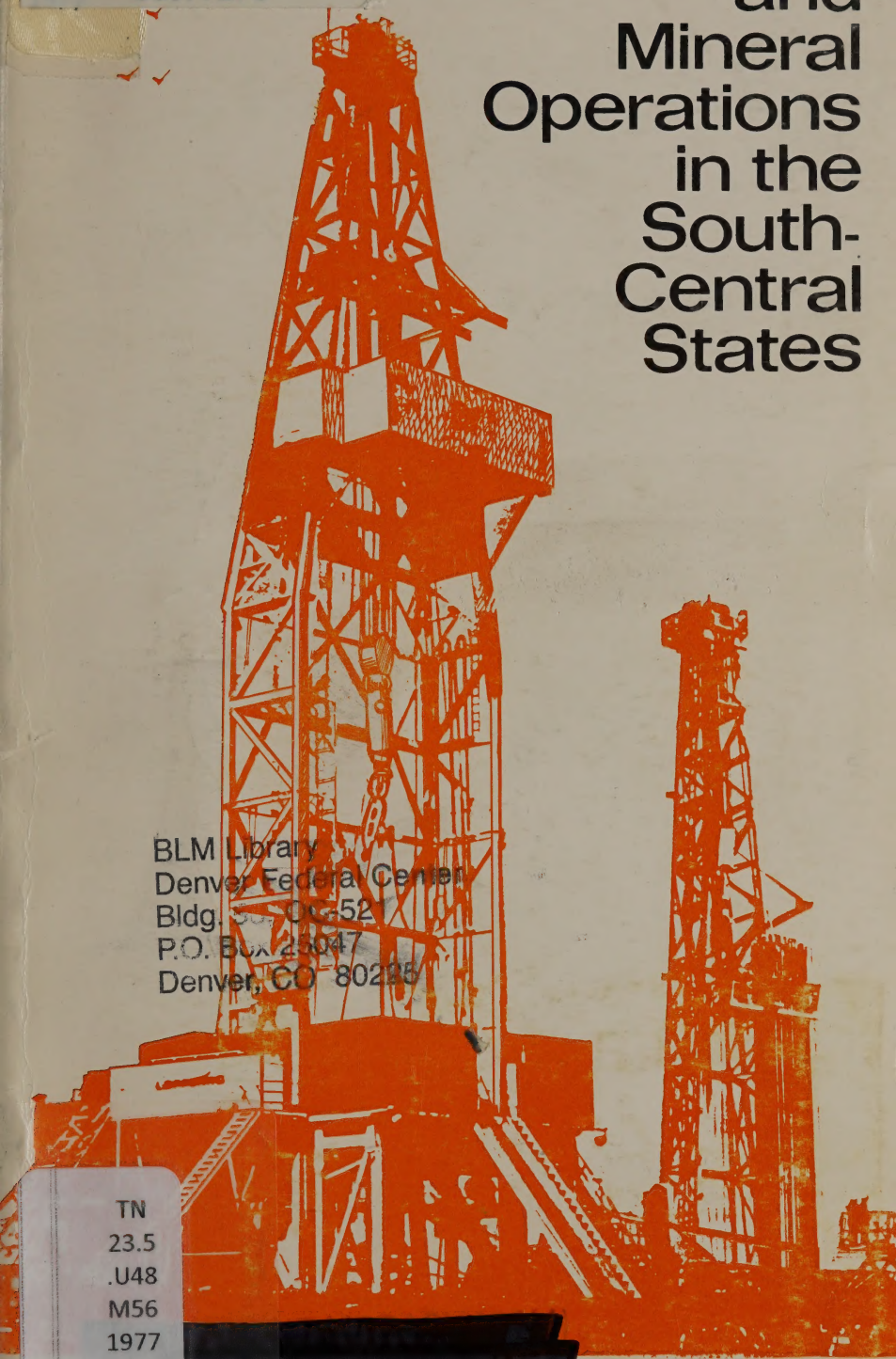
Mining and Mineral Operations in the South-Central States



A Visitor Guide

MINING AND MINERAL OPERATIONS IN THE SOUTH-CENTRAL STATES

A VISITOR GUIDE

BY BUREAU OF MINES STATE LIAISON OFFICERS

1977

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INTRODUCTION

Minerals are vital to any industrialized civilization. Annually, the United States uses more than 4 billion tons of new mineral materials, or about 40,000 pounds per person—about half being mineral fuels and the other half being metals and nonmetallics. Stable and economic domestic mining, mineral, metal, and mineral reclamation industries are essential to the economy. The value of United States energy and processed materials of mineral origin exceeds $200 billion annually. Although a number of minerals are imported, especially some designated as "strategic and critical," most U.S. mineral supplies are derived from the domestic mines and processing facilities that you will be seeing, reading about, and visiting as you use this visitor guide. We hope you enjoy your experiences.

This pamphlet, a guide to mining and mineral operations that may be observed or visited and some other points of interest relating to minerals, is intended to aid tourists and students who are interested in mining. Some may wish to study our Nation's romantic past; others may plan to enter the minerals industry as a career; still others may have a primary interest in conservation practices. The pamphlet is also intended to aid State and local officials, Chambers of Commerce, and mining firms in answering some of the many questions of tourists and students.

Six visitor guides have been prepared covering mining operations in the United States. The regions covered by these guides are the New England and Mid-Atlantic States, the South Atlantic States, the North-Central States, the South-Central States, the Rocky Mountain States, and the Pacific States.

The text provides interesting highlights about mines and mineral operations that travelers may see from the highways. Longer descriptions of mines and plants that can be visited sometimes are provided. The mines mentioned are representative samples and are those most easily observed from, or are near, major highways. There are many others that are operating but are more remote. Selected references for detailed study are also included.

The Bureau of Mines publishes a Minerals Yearbook each year that summarizes the national production and status of each mineral commodity. The mineral industry production and status for each State are described in separate chapters. The Yearbook may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Separate chapters are available free from Publications Distribution Branch, Bureau of Mines, U.S.

Department of the Interior, 4800 Forbes Avenue, Pittsburgh, Pa. 15213.

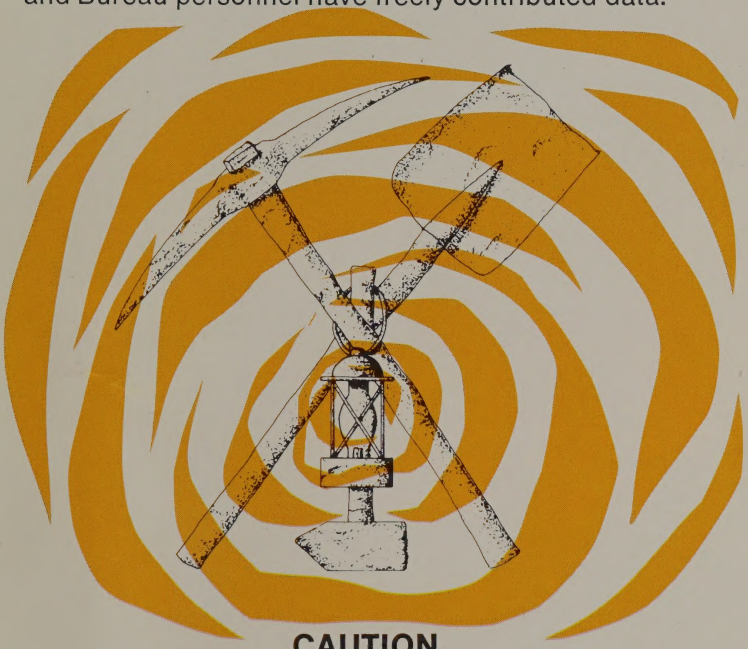
Students who have a deep interest in some branch of mining will find most mine managers willing to help, even though the mine may not be open to casual tourists.

If you leave well-traveled highways to visit ghost towns, tell someone where you are going and when you expect to get back. You should also inquire locally about road conditions before traveling unpaved or unimproved roads.

Bring your camera. Many prize-winning photographs have been obtained at the areas mentioned in this pamphlet.

ACKNOWLEDGMENTS

Acknowledgments are due those who helped prepare this pamphlet. State geologists, State Offices of Information, Chambers of Commerce, mine managers, and Bureau personnel have freely contributed data.



CAUTION

Remember that abandoned mines are death traps. Stay out of them. Old shafts often cave near the surface and form a funnel-shaped opening. Unwary visitors have been trapped in these funnels. Stay away from old shafts!

Always use available guide services. Mine openings (tunnels, adits, open pits) should never be entered except with a competent guide.

Sometimes the air is bad in abandoned mines and is not safe to breathe. Explosive gas may also be present. Gases frequently come from the rocks themselves, but during active operations, they are swept out of the mine by the controlled ventilating current.

Remember, too, that even the oldest mines usually are private property. Most mine owners do not object to the collection of a few mineral specimens (some do charge a fee), but all object to touring vandals, who wantonly destroy buildings and equipment, or to inexperienced trespassers, who present a hazard to themselves, the property, and the owners.

A blast furnace at Gadsden, Ala. (Courtesy of Republic Steel.)

ALABAMA

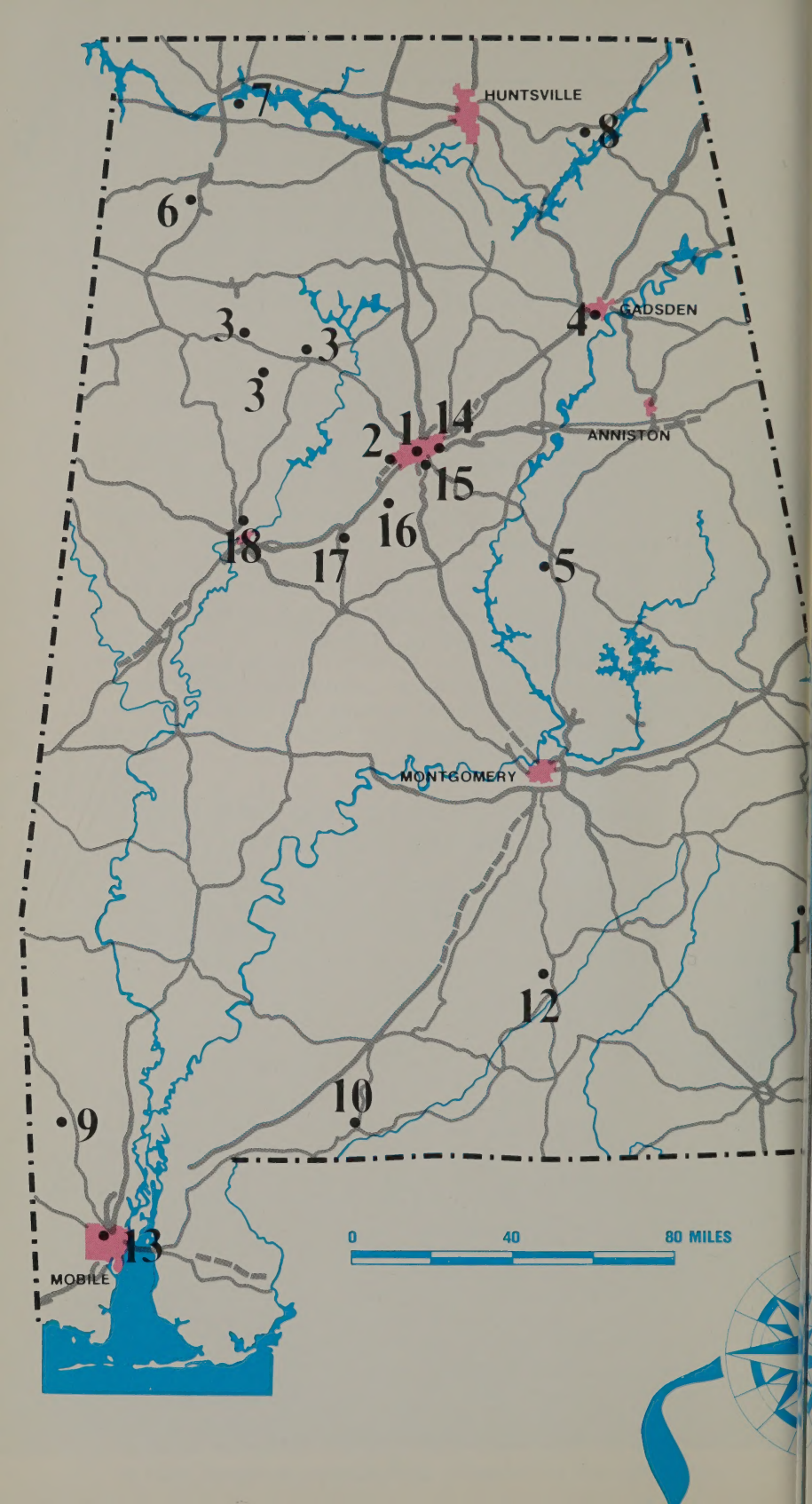
by
James R. Boyle

Mineral deposits, rich soil, and gentle climate attracted man to Alabama. Although an agrarian civilization developed, the close proximity of iron ore, coal, and limestone in the Birmingham area started the industrial development that continues to this day. Because of the uniqueness of these minerals in the Birmingham area, it soon became known as the Pittsburgh of the South. The rapid growth of the steel industry and the city with it, gave Birmingham its nickname, the magic city. Alabama ranks 21st in the Nation in value of mineral production; its principal products are coal, stone, cement, and petroleum. Domestic iron ore production has virtually ceased, being replaced by higher grade imported ores.

MINES AND PLANTS YOU CAN SEE FROM THE HIGHWAY

U.S. 280.—On the Red Mountain Expressway in southeastern Birmingham, the Red Mountain cut exposes more than 440 million years in geologic time. (map location 1). A myriad of fossils and a great variety of mineral and rock types are exposed. Visible formations include the Big Seam iron ore formation, sandstones, shales, cherts, and limestones in the deepest road cut in the Southeast, which measures 1,850 feet long and 210 feet deep. 1

In the Fairfield and Ensley area of Birmingham, United States Steel Corp. has steelmaking facilities, and in nearby East Thomas, Republic Steel Corp. also has furnaces (map location 2). Both of these operations contributed substantially to the growth of Birmingham. U.S. Steel's blast furnaces feed two new basic oxygen furnaces. These units, each with a capacity of 200 tons, make steel 10 times as fast as the old open hearths. They are the first such units built in the Western Hemisphere and the largest in the world. An important advancement environmentally, with controls these units reduce particulate emissions by 99 percent over previous steelmaking facilities. 2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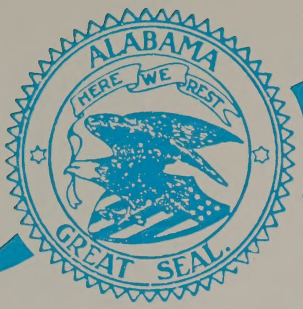

LEGEND

1— Red mountain cut
2— Steel mills
3— Warrior coalfield
4— Steel mills
5— Marble quarries
6— Open pit iron ore mines
7— Aluminum reduction plant
8— Aluminum reduction plant
9— Oil and gas field
10— Oil and gas field
11— Bauxite mining district
12— Iron ore mining district
13— Ore docks
14— Historic iron furnaces
15— Historic Vulcan Park
16— Underground iron ore mines (inactive)
17— Historic ironworks
18— Rock and mineral museum

Molten iron being charged into a basic oxygen furnace at Birmingham, Ala. (Courtesy of United States Steel Corp.)

U.S. 78.—In the vicinity of Jasper and Carbon Hill lies the Warrior coalfield. Numerous mining operations are active in the area, some of which are visible from U.S. 78 (map location 3). Draglines are utilized to strip overburden, and smaller loaders load the coal. The coalfield also extends south to Tuscaloosa, but most operations are visible only from secondary roads.

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Interstate 59.—East of Interstate 59 at Gadsden, Republic Steel Corp.'s steel plant has two basic oxygen furnaces, each of which can produce 180 tons of steel in 45 minutes (map location 4). Raw material input, temperatures, and other requirements are regulated by computer. Plant capacity exceeds 1 million tons annually.

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U.S. 280.—Southeast of Birmingham near Sylacauga, marble quarries are visible at Gantts Quarry (map location 5). Production dates from 1840; the marble is used for monuments, building, decoration, and agricultural lime.

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U.S. 43.—West of Russellville, off U.S. 43, brown iron ore surface mining, which first started in 1815, can be seen (map location 6). Twenty miles north, in Sheffield, Reynolds Metals Co. has its largest aluminum reduction plant, producing 221,000 tons of aluminum per year, utilizing Tennessee Valley Authority (TVA) power (map location 7). Adjacent is the Alabama smelting plant that recycles old aluminum cans and scrap.

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U.S. 72.—Off U.S. 72, south of Scottsboro, is Revere Copper and Brass' new aluminum reduction plant that produces over 100,000 tons of aluminum per year (map location 8).

U.S. 45, U.S. 31, U.S. 29.—Oil and gas activity is scattered throughout the State, but producing units can be seen north of Mobile on U.S. 45 at Citronelle and in the Brewton area, U.S. 31 and U.S. 29 (map locations 9–10, respectively).

U.S. 431, Ala. 30.—Bauxite is mined in the Eufaula area; visible activity is limited to secondary roads (map location 11). Alabama ranked second in the Nation in bauxite production; the material is used primarily in the manufacture of materials for construction of high-temperature furnaces.

U.S. 29.—Brown iron ore is mined between Luverne and Brantley and is used as a supplemental feed to the furnaces in Birmingham and Gadsden (map location 12).

U.S. 43.—Mobile offers additional mineral related activities; the State Docks are located here and usually may be visited upon request (map location 13). Minerals imported are bauxite and iron ore. The bauxite is sent to the nearby Alcoa plant for conversion to alumina. The iron ore is barged up river to the Birmingham area for use in the steel plants. Coal, mined in Tuscaloosa, Walker, and Jefferson Counties, is barged to Mobile for export. A new coal loading facility, capable of loading 4,000 tons per hour, is located on nearby McDuffie Island. Oystershell, used in

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An oyster shell dredge in Mobile Bay, Ala.

cement and construction, is dredged from Mobile Bay. The operation can be observed from the shoreline.

HISTORICAL SITES

14 **U.S. 11.**—The old U.S. Pipe & Foundry Co.'s blast furnace operations in Birmingham are visible from the First Avenue viaduct at 32d Street (map location 14). Plans are underway to develop the area as a museum in commemoration of the development of the steel industry in the area.

Vulcan Park overlooking Birmingham, Ala.

15 **U.S. 31 S.**—At the crest of Red Mountain is Vulcan Park, which contains a statue of Vulcan overlooking Birmingham (map location 15). It is the second largest statue in the Nation, standing 55 feet high, and weighing 60 tons. It commemorates the opening of the red iron ore mines in 1876, one of the most important factors in the industrial development of the South. At night a spectacular panoramic view of Birmingham and the steelmaking operations can be seen.

16 **Ala. 150.**—The last operating underground iron ore mine, closed in 1971, is the Pyne mine of Woodward Co., visible from Ala. 150, about 4 miles east of Bessemer (map location 16).

17 **Interstate 59.**—About 10 miles south of Bessemer, off Interstate 59, is the Tannehill Furnace State Park (map location 17). From 1829 to 1865, iron ore was hauled by oxcart, reduced by charcoal, and made into plows, pots, cannon, and munitions. Dating to 1829, the forges were one of the first in the State.

On the campus of the University of Alabama at Tuscaloosa is a rock and mineral museum that is open to the public. (map location 18). Nearby are the offices of the Geological Survey of Alabama and the State Oil and Gas Board. **18**

FOR MORE INFORMATION WRITE OR VISIT

Birmingham Area Chamber of Commerce, 1914 Sixth Avenue North, Birmingham, Ala. 35203.

Federal Bureau of Mines Liaison Office, P.O. Box L, University, Ala. 35486.

State Geologist, Geological Survey of Alabama, P.O. Drawer O, University, Ala. 35486.

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Base and Precious Metal and Related Deposits of Alabama, by S. I. Spaine. Geological Survey of Alabama, Circular 55, University, Ala., 1969, 94 pp.

Rocks and Minerals of Alabama—A Guidebook for Alabama Rockhounds, by T. W. Daniel, Jr., T. L. Neathery, and T. A. Simpson. Geological Survey of Alabama, Circular 38, University, Ala., 1966, 106 pp.

Ghost camp at Rush, Ark. (Courtesy of Arkansas Geological Commission.)

ARKANSAS

by
Raymond B. Stroud

Arkansas mineral production is unique, diversified, and economically significant in the State and Nation. Diamonds in Arkansas occur in the rock in which they were formed—the only such place on the North American Continent. Arkansas novaculite, a naturally occurring abrasive stone, was mined in the State by Indians prior to the time of De Soto's travels in the United States. More than 20 mineral fuels, metals, and nonmetallic minerals are produced annually. Arkansas leads all others in production of bauxite, bromine, and vanadium, and ranks third in the United States in barite output. Arkansas had led in output of bauxite (the ore of aluminum) since 1900, and alumina plants and aluminum reduction facilities are operated in the State. Five bromine-recovery plants in the southern part of the State have a total productive capacity of more than 300 million pounds. The element is converted to ethylene dibromide and is widely used as a scavenging agent in leaded gasolines. The largest and most productive vanadium mine in the United States is near central Arkansas. Vanadium concentrates from the mine-mill complex are used extensively by the steelmaking industry. Barite output in Arkansas is used in compounding drilling muds that are employed throughout the United States by the oil and gas industry on well-drilling operations.

MINES AND PLANTS YOU CAN SEE FROM THE HIGHWAYS

Interstate 30, Ark. 183.—Bauxite is mined in the area between Little Rock and Benton. The mines east of Interstate 30 are visible from a number of State and county roads. Ark. 183, which intersects Interstate 30 at Benton and again at a point 8 miles north, passes through the southwest part of the bauxite district. Many bauxite mines and one alumina plant may be seen from this road (map location 1). Alumina is an intermediate product made at the plant from bauxite; alumina is converted to aluminum metal by an electrometallurgical process.

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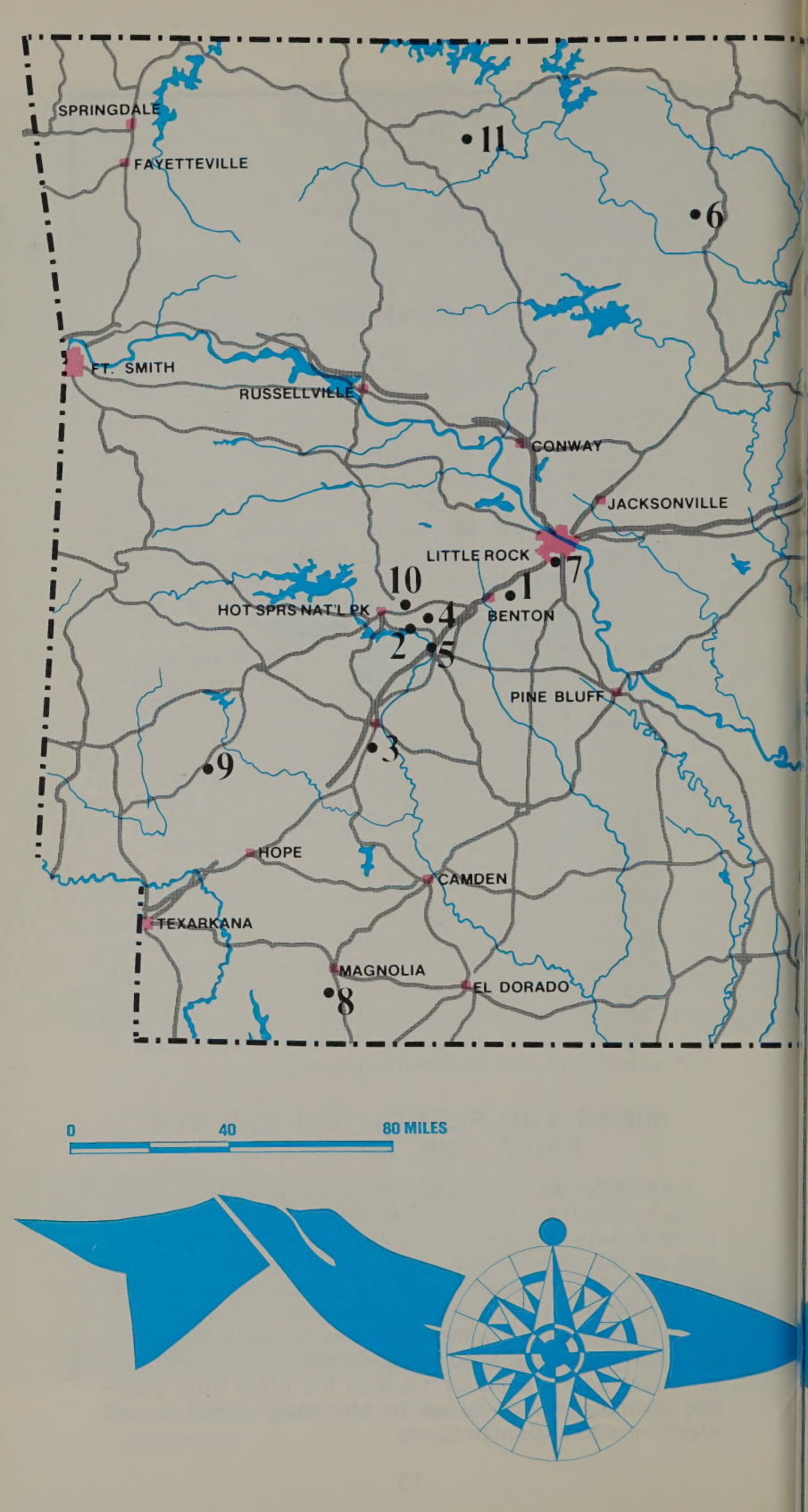
SPRINGDALE
FAYETTEVILLE
FT. SMITH
RUSSELLVILLE
CONWAY
JACKSONVILLE
LITTLE ROCK
HOT SPRS NAT'L PK
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HOPE
CAMDEN
TEXARKANA
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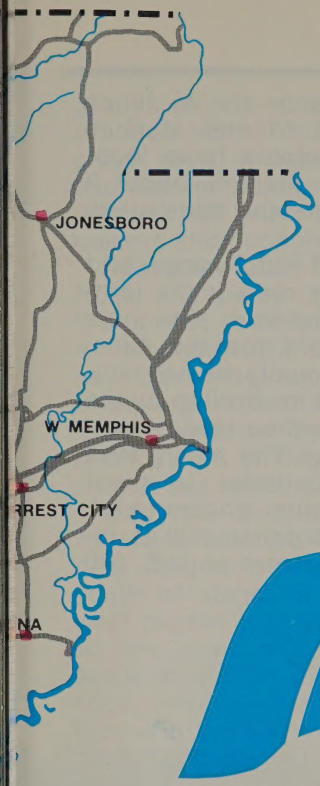

LEGEND

1— Bauxite mining district
2— Aluminum reduction plant
3— Aluminum reduction plant
4— Largest U.S. barite mine
5— Barite processing plant
6— Manganese mining district (inactive)
7— Nepheline syenite quarry
8— Bromine recovery plant
9— Diamond deposits
10— Open pit vanadium mine and mill
11— Zinc mining district (inactive)

Ark. 51, Ark. 26.—Aluminum plants are at Jones Mill northwest of Malvern on Ark. 51 and at Gum Spring on Ark. 26 south of Arkadelphia (map locations 2–3, respectively). The latter plant is about 3 miles east of Interstate 30. The plants and mine areas can be viewed from the roads.

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U.S. 270.—About 15 miles east of Hot Springs, and 2 miles north of Magnet on a county road, is the largest barite mine in America (map location 4). The mine is not open to the public. The product from this mine, barite (barium sulfate, an exceptionally heavy mineral), is ground to make heavy mud for drilling by the oil and gas industry. More than 1 million tons of barite is used annually for well drilling. The heavy mud helps prevent blowouts in drilling holes to great depths where high pressures are often encountered. A large barite grinding plant and flotation mill is located at the western city limits of Malvern on U.S. 270 (map location 5).

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Manganese mine north of Cushman, Ark.

Ark. 69.—One of the oldest manganese mines in Arkansas and the United States is 1 mile north of Cushman on Ark. 69 (map location 6). The mine is not being operated but may be viewed from a eastward trending county road. The mine is one of several in what at one time was a highly productive manganese industry center at Batesville. Depletion of the higher

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grades of ore coupled with changes in metallurgical practice led to changed marketing conditions and a sharp drop in production. The large manganese resources in the Batesville district, presently subcommercial, will likely be utilized in future years as technologic and economic conditions change.

Interstate 30.—On the southeast edge of Little Rock and visible to the passerby traveling south is the largest rock quarry in the State (map location 7). At this quarry, and combined with several others in near proximity, nepheline syenite is mined at the rate of several million tons annually. The syenite is used for all types of building and construction and finds applications in the roofing granules industry. Drivers should use caution in this area. 7

U.S. 79.—One of five bromine recovery plants in Arkansas and the largest of its kind in the Nation is near Magnolia (map location 8). At a point 5 miles south of Magnolia on U.S. 79, a county road to the west passes just north of the bromine recovery plant. At this plant, as at the other plants, brine, which is associated with the oil and gas productive area of south Arkansas, is pumped through wells to the surface and transferred to the bromine plant where bromine is extracted and converted to bromine compounds. The bromine compounds are used primarily as an additive in leaded gasoline, and also for sanitation, fire extinguisher charges, and other chemical applications. The bromine industry in Arkansas is the largest in the United States. 8

MINES YOU CAN VISIT

Ark. 301.—Diamond-bearing areas are 2 miles south of Murfreesboro on Ark. 301 (map location 9). In past years, large-scale attempts to operate the deposits have not led to sustained production. One of the larger diamond-bearing areas has been incorporated into the State Park system and is open to the public. For a fee of $2 an individual can search for diamonds. Persons sharp-eyed and lucky that find diamonds may keep what they find. A find of a stone as large as 5 or 6 carats each year is not unusual. Some visitors are reported to have found diamonds as large as 15.22 carats uncut. Group rates are available to parties of people who visit the site. The surface area is plowed and dozed regularly to turn over fresh dirt. Sink-float tests are provided at the site to detect diamonds. An estimated 50,000 stones averaging one-fourth carat have been found since the deposits were discovered in 1904. 9

U.S. 270.—Vanadium ore mining and concentrating operations are open to visitors only by prior arrangement with company management. The mine-mill com-

Vanadium extraction plant southeast of Hot Springs, Ark. (Courtesy of Union Carbide Corp.)

plex was opened in 1967 following several years of extensive exploration, development, and metallurgical research (map location 10). Vanadium-bearing ore, gritty to claylike in texture and of varigated color, is mined by open pit methods. Mined ore is stockpiled and later treated to recover metal values by salt roasting, leaching, and solvent extraction procedures. Most vanadium is used as ferrovanadium by the steel-making industry.

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GHOST TOWNS AND HISTORICAL SITES

Ark. 14.—A ghost camp and zinc mines and mills are at Ruch, Marion County, which is 4 miles east of Ark. 14 at a point 14 miles south of Yellville (map location 11). The site is 8 miles north of Buffalo River State Park. Touring is unrestricted, but remember the safety rules mentioned in the front of this guide and that this is private property. Local inquiry should be made by all visitors for safety's sake.

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FOR MORE INFORMATION WRITE OR VISIT

Arkansas Geological Commission, Vardelle Parham Geology Center, 3815 West Roosevelt Road, Little Rock, Ark. 72204.

Arkansas Parks and Tourism Department, 149 State Capitol, Little Rock, Ark. 72201.

Federal Bureau of Mines Liaison Office, Room 3331 Federal Building, 700 West Capitol, Little Rock, Ark. 72201.

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Contour coal stripping.

KENTUCKY

by
William T. Boyd

Kentucky's mineral industry began in 1750 when coal was first discovered along the Warrior Trail just north of Cumberland Gap. Principal minerals now produced, listed in order of value, are bituminous coal, crushed and dimension stone, petroleum, natural gas, sand and gravel, and clays, along with small amounts of fluorspar and zinc ores. Kentucky has a colorful history in coal mining and, during recent years, has led the Nation in production of bituminous coal, producing nearly 21 percent of the annual supply.

COAL

Kentucky's coal reserves are contained in two large areas commonly referred to as the Eastern and Western coalfields. The Eastern field constitutes a portion of the Appalachian coalfield, totaling nearly 11,000 square miles, and 33 minable coalbeds occur within this 31-county area. The bulk of coal production is concentrated in about 17 counties, and Pike, Harlan, Perry, Letcher, and Breathitt Counties are the leading producers. More than 1,400 mines are scattered throughout this vast area, of which about 200 are surface or contour stripping operations. The coals are high-volatile bituminous with low sulfur and ash content and are much in demand for metallurgical and byproduct purposes. The Western coalfield is an extension of the Illinois coal measures, and seven coalbeds occur within this 14-county area. Owing to the topography, these coals are recovered mostly by area surface-mining methods using massive, large-capacity loading and hauling equipment. The coals have a rather high sulfur content and are used mostly by the Tennessee Valley Authority (TVA) and private utility groups for thermal-power generation purposes. About 92 rather large surface and 32 medium-sized underground mines produce about 49 million tons of high-volatile bituminous coal annually.

MINES AND PLANTS YOU CAN SEE FROM THE HIGHWAY

Ky. 15.—This highway extends from Campton to Whitesburg and traverses some of the most rugged coal-bearing lands in eastern Kentucky. It provides an excellent view of many coal tipples located along the route or clinging to the mountainsides, as well as a few mining towns and some contour stripping operations. It also provides an excellent view of the results of surface coal mining in this rugged terrain (map locations 1–2).

U.S. 23.—From Ashland to Prestonsburg, many active and abandoned underground and contour strip mines are visible along both sides of the highway. The abandoned coal tipples, along with the remnants of company towns and company stores, may be seen extending back into long-forgotten valleys (map locations 3–4).

U.S. 119.—Along this road, from South Williamson to Jenkins, near the Virginia border, are many underground and surface coal mines (map locations 5–6). The surface coal preparation plants are usually visible from the highway, and the results of early contour stripping operations completed before reclamation laws were passed may be seen high upon the mountainsides.

U.S. 431.—This highway bisects the largest coal-producing county in western Kentucky (Muhlenberg) and provides an excellent view of area coal-stripping operations. Large areas of mined lands in various stages of reclamation can be seen along both sides of the highway (map location 7).

Western Kentucky Parkway.—This highway, between the intersections of U.S. 231 near Beaver Dam and U.S. 41 near Morton's Gap, provides an excellent view of some large surface-mining operations using massive extraction and transporting equipment (map locations 8–9). Many of the large draglines that are visible from the highway can move more than 100 tons of material per minute, and the extremely large trucks carry loads of nearly 100 tons to nearby thermal powerplants.

Ky. 181.—The TVA Paradise powerplant is located near Greenville on the south side of Ky. 181 (map location 10). This 2.5-megawatt thermal powerplant presently is the largest coal-burning plant in the world and, as you can imagine, is quite an impressive facility.

STONE

There are 135 commercial crushed stone operations scattered throughout the central and western

LEGEND

1— Surface coal mining district
2— Surface coal mining district
3— Underground and contour strip coal mines
4— Underground and contour strip coal mines
5— Underground and surface coal mines
6— Underground and surface coal mines
7— Strip coal mining area
8— Large surface coal mining operations
9— Large surface coal mining operations
10— Paradise powerplant
11— Underground limestone mine
12— Underground limestone mine
13— Underground limestone mine
14— Large limestone quarry
15— Limestone quarry
16— Limestone quarry
17— Limestone quarry
18— Limestone quarry
19— Limestone quarry
20— Limestone quarry
21— Sand and gravel operation
22— Sand and gravel operation
23— Open pit clay mines
24— Open pit clay mines
25— Oil and gas wells
26— Oil and gas wells
27— Petroleum refinery
28— Petroleum refinery
29— Petroleum refinery
30— Large blast furnace
31— Alumina smelter
32— Aluminum reduction plant
33— Fluorspar mines
34— Fluorspar mines
35— Iron foundry ruins

An open-face limestone quarry.

portions of the State. Although the majority of these are open-face or surface mine operations mostly producing crushed stone for highway and surface construction, several underground operations are located along the Ohio River and produce a high-calcium limestone for the chemical and agricultural industries (map locations 11–13). Many of the quarry openings may be viewed along the highways in the central portion of the State.

U.S. 460.—The Bourbon Limestone Co. (Quincy Quarries) has a large operation near Paris (map location 14). This is an open-face operation using conventional extraction methods and equipment.

U.S. 25.—The Vulcan Materials Co. has a large quarry operation just west of the highway near the Kentucky River with an open face of about 35 feet (map location 15).

Interstate 75.—Two medium-sized quarry operations belonging to the Nally & Gibson Association are situated near Georgetown, and the Central Rock Co. has a fairly large quarry located near Lexington. (map locations 16–17, respectively). These open-face quarries mostly provide crushed stone for nearby construction operations.

Interstate 65.—Several open-face quarry operations are conducted along this highway near Shepherdsville in Bullitt County and near Okolona in Jefferson County (map locations 18–19, respectively).

Interstate 64 and 75.—A medium-sized, open-face quarry is being developed at the intersection of these interstate routes (map location 20).

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SAND AND GRAVEL

21 22 More than 45 different operations produce sand and gravel at locations scattered throughout 22 counties, and these products are used largely in highway and residential construction. Several large operators use small dredges and are situated along the Ohio River (map locations 21–22).

CLAYS

23 24 Several small open pit clay mining operations are situated in the eastern and extreme western portions of the State (map locations 23–24). These mines produce nearly a quarter of a million tons of clay annually, which is used primarily for production of fire and building bricks.

OIL AND GAS

25 26 Although oil and gas production has declined in recent years, several thousand producing wells are located in Floyd, Pike, Martin, and Knott Counties, as well as the Crittenden-Livingston County area in the western portion of the State (map locations 25–26). Many of these pumping facilities can be viewed from nearby highways. Also, several new, deep-drilling 27 operations are now being conducted in these same areas. Along with this petroleum production, three 28 refineries are located nearby (map locations 27–29). The Ashland Oil Corp., which has a large refinery at 29 Ashland, Ky., gladly arranges guided tours for groups upon advance notification and approval.

Sand and gravel operation.

Coal preparation plant. (Courtesy of Beth-Elkhorn Corp.)

ORE REDUCTION FACILITIES

Much of the heavy industry is located along the Ohio and Big Sandy Rivers, easily accessible for bulk transportation of ores and petroleum production. In Ashland (map location 30), the Armco Steel Corp. has constructed one of the largest blast furnaces in the Western World. Also, the National-Southwire Aluminum Co. has recently doubled the capacity of the alumina smelter located in Hancock County (map location 31), and Anaconda is developing the world's largest aluminum reduction plant near Owensboro (map location 32).

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FLUORSPAR

Many of the vein-type fluorspar operations have been marginal for several years in western Kentucky (map location 33), but two companies have recently developed new mines near Calvert City, and an extensive exploration survey is being made to determine the extent and quality of these resources. One new mine shaft is being sunk near Marion (map location 34), and other openings are planned.

33

34

MINES YOU CAN VISIT

None of the mining companies operating in Kentucky have established a policy for visitors. Although the Beth-Elkhorn Coal Corp. located at Jenkins has arranged, upon proper notification and approval, guided tours for schools and other groups, they have no scheduled tours. Generally speaking, mining companies discourage visits from the general public, mainly because of the inherent safety hazards for persons not familiar or trained to recognize these conditions.

Old contour coal stripping operation.

Several large strip coal operations are situated near the Western Kentucky Parkway, and visitors can observe the large-capacity draglines and shovels from the highway and see many 100-ton trucks hauling coal from these operations to nearby TVA thermal powerplants.

GHOST TOWNS AND HISTORICAL SITES

There are many old mining communities in eastern Kentucky where the miners have left abandoned or worked-out mines and moved on to other areas, thus leaving old mining structures, deserted communities of silent houses, and old company office buildings. Visiting these communities can be an interesting experience, but visitors should be extremely cautious around old mine structures and mine openings.

Two places of interest that should certainly be visited by tourists are the Kentucky Geological Survey museum and the Ben Clement Fluorspar Museum. In Lexington, the Kentucky Geological Survey maintains a rock and mineral museum on the campus of the University of Kentucky and, at Marion, the Ben Clement Fluorspar Museum contains a famous collection of fluorspar minerals.

In the early 1800's, many small iron foundries were constructed in eastern and western Kentucky using the nearby low-grade ores and charcoal for heating purposes. However, with later development of large, high-grade iron ore deposits in the Lake Superior area, these operations were abandoned and most furnaces were destroyed. In the Land-Between-The-Lakes area (map location 35), the remnants of several furnaces are still standing, and TVA has reconstructed access roads and is encouraging visitors to view these old industrial sites. The Center Iron Furnace was operated intermittently for 65 years and, during its periods of maximum production, employed about 300 men and produced about 16 tons of pig iron daily.

35

FOR MORE INFORMATION WRITE OR VISIT

Federal Bureau of Mines Liaison Office, Room 269, 330 West Broadway, Frankfort, Ky. 40601.

Kentucky Department of Mines and Minerals, P.O. Box 680, Lexington, Ky. 40501.

Kentucky Department for Natural Resources and Environmental Protection, Plaza Tower, Frankfort, Ky. 40601.

Kentucky Geological Survey, 120 Graham Avenue, Lexington, Ky. 40506.

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Night Comes to the Cumberlands, by H. Caudill. Little Brown & Company, Boston, Mass., 1962, 394 pp.

A replica of the derrick that appeared at the first oil well in Louisiana drilled near Jennings, La.

LOUISIANA

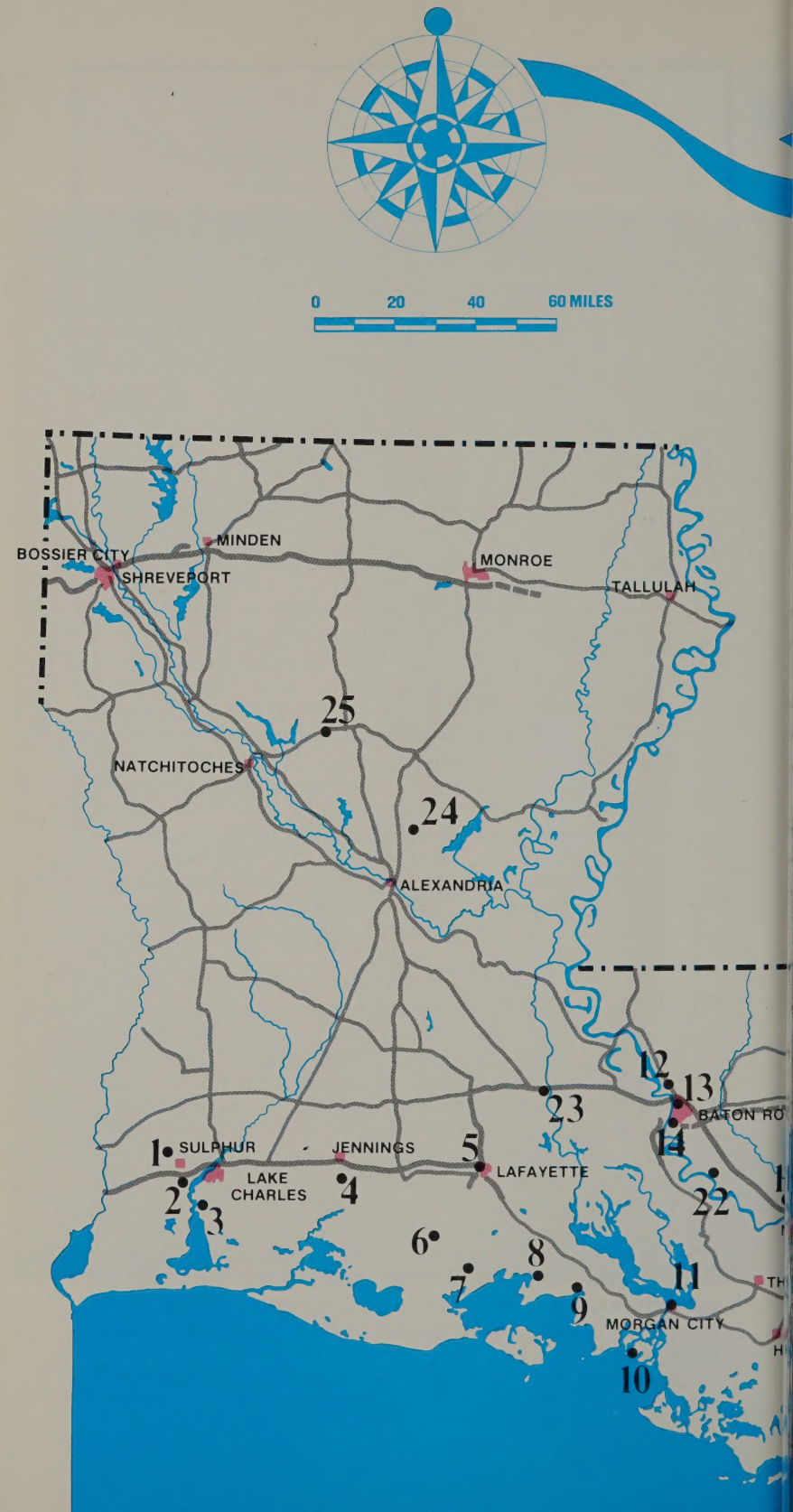
by
Owen W. Jones

Louisiana has ranked second in domestic mineral production value for 16 consecutive years. Mineral fuels production—crude petroleum, natural gas, and natural gas liquids—ranked second only to Texas and provided approximately 96 percent of Louisiana's total mineral production value. The petroleum industry was born in Louisiana on September 21, 1901, when the State's first oil well was discovered in a rice field near Jennings (historical marker and well replica at Jennings). Oil and gas fields are now widely scattered throughout the northern one-third, and the southern one-half of the State, as well as more than 100 miles offshore. These fields, although numerous, ordinarily do not lend themselves to being tourist attractions because wells are scattered, and many times a tourist could drive through the middle of a field and hardly realize it was there. Offshore drilling and production platforms, while very interesting, are too busy and crowded to allow visitors, and transportation to them would have to be by helicopter or by boat. Some of them can be viewed at a distance from coastal highways.

Louisiana ranks first in salt production. New Iberia, in the beautiful Bayou Teche country, is a center for rock salt mining.

Louisiana ranks second in Frasch sulfur production. Louisiana and Texas each furnish approximately one-half of the total Frasch sulfur production in the United States. Sulfur, present in the cap rock of some intrusive salt domes, is melted by hot water injection. The liquid sulfur is lifted to the surface by compressed air. All the sulfur mines are in swamps or offshore, and the mine sites are not available to tourists. However, Port Sulphur, in Plaquemines Parish, the central gathering place for sulfur shipments, does present an opportunity to see and photograph tremendous blocks of solid bright yellow sulfur and sulfur boats being loaded.

Other minerals produced in Louisiana include sand and gravel, oystershell (converted into lime, cement,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SHREVEPORT
MINDEN
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TALLULAH
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SULPHUR
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LEGEND

- Sulphur salt dome
- Lake Charles industrial area
- Consolidated Aluminum Corp. reduction plant
- Jennings-birthplace of Louisiana petroleum industry
- Heymann oil center
- Jefferson Island salt dome
- Avery Island salt dome
- Weeks Island salt dome
- West Cote Blanche Bay salt dome
- Belle Isle salt dome
- Pelican lime plant
- Ideal Cement Co.

13— Kaiser Aluminum & Chemical Corp. Baton Rouge alumina plant

14— Exxon refinery—one of the largest in the world

15— Kaiser Aluminum & Chemical Corp. Gramercy alumina plant

16— Kaiser Aluminum & Chemical Corp. Chalmette reduction plant

17— American Metals Climax Inc.-Port Nickel Refinery

18— Port Sulphur

19— Fort Jackson

20— Gulf Oil Corp. Venice Refinery

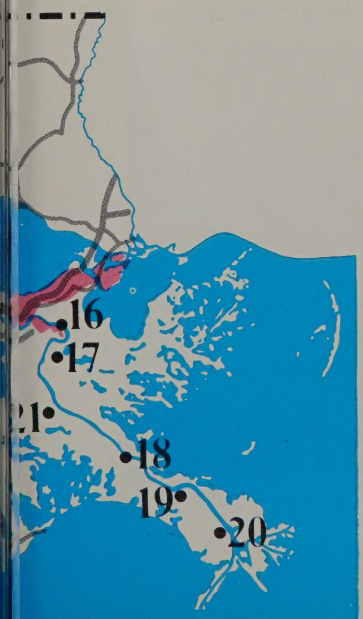
21— Gulf Oil Corp. Myrtle Grove Refinery

22— Geismar—example of intensive petrochemical growth along Mississippi River—Baton Rouge to New Orleans—known as "the American Ruhr"

23— Big River Industries Inc. lightweight aggregate plant

24— Fishville, La., sand and gravel pit

25— Abandoned salt mine—operating rock quarry



and used for road fill as a substitute for gravel), and clay.

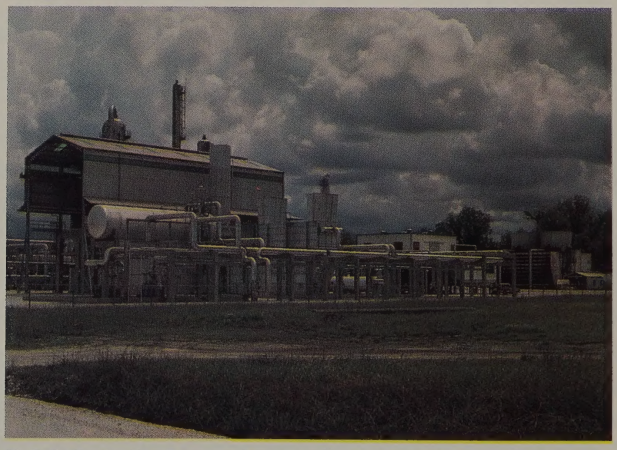
The metals industry of Louisiana (aluminum and nickel) is dependent on imported ores. The industry is not included in the mineral output value previously mentioned but is a very important part of the mineral industry of the State. Imported bauxite is processed into alumina (aluminum oxide) at the Gramercy and Baton Rouge plants of Kaiser Aluminum & Chemical Corp. (Kaiser) and at the Burnside plant of Ormet Corp. Metallic aluminum is produced at the Kaiser reduction plant at Chalmette and the Consolidated Aluminum Corp. (Consol) plant in Lake Charles. Imported nickel concentrates are processed by the American Metal Climax Inc. (AMAX) refinery at Braithwaite.

MINES AND PLANTS YOU CAN SEE FROM THE HIGHWAY

Louisiana has some very interesting mineral operations, although most of them are in remote places, or industrial insurance requirements discourage tourist visitors.

One very interesting area lies just downriver from New Orleans in Plaquemines Parish. This area is one of the richest, from mineral income, in the United States. It produces petroleum, natural gas, Frasch sulfur, natural gas liquids, salt brine, and sand and gravel worth billions of dollars. The entire parish is barely above sea level, and the Mississippi River traverses the length of this deltaic parish. An interesting mineral tour of this area might be as follows:

La. 39.—On the east bank of the Mississippi River at Chalmette—about 10 miles from downtown New Orleans—is the Chalmette National Cemetery and



Shell Oil Co.'s St. Bernard natural gas processing plant on La. 46 west of Yscloskey.

Sulfur ship being loaded at the dock at Port Sulphur on La. 23, 45 miles downriver from New Orleans.

Historical Park where the Battle of New Orleans was fought. Just to the east of the cemetery is the Kaiser Aluminum Co. reduction plant (map location 16). Here, the white powdery alumina from the Baton Rouge and Gramercy plants is reduced electrically to metallic aluminum. **16**

Downriver 15 miles from Chalmette is the American Metal Climax Inc. (AMAX) Port Nickel refinery at Braithwaite (map location 17). Built by the Cuban American Nickel Co. in 1959 to process nickel-cobalt sulfide concentrates from Cuba, the plant was closed after 9 months of operation when supplies were cut off following Cuban nationalization of U.S.-owned mines. It had been maintained on a standby basis until purchased in about 1971 by AMAX to process nickel-copper concentrate from Botswana, Africa. To the east of the nickel plant, in St. Bernard Parish, are some very large natural gas processing plants, a possible side trip. **17**

Downriver 25 miles from the nickel refinery on La. 39 is Pointe-a-la-Hache, where a free ferry crosses the Mississippi to La. 23 on the west bank. Here, the traveler may turn back upriver to New Orleans or turn downriver toward Venice, where the road ends approximately 75 miles downriver from New Orleans. The nearest point of interest downriver is Port Sulphur.

La. 23.—Port Sulphur is 45 miles downriver from New Orleans or about 10 miles downriver from the Pointe-a-la-Hache ferry landing (map location 18). This town was established by Freeport Sulphur Co. as a gathering place and loading dock for the Frasch sulfur from Freeport's mines in the vicinity. None of the sulfur mines are accessible by highway, but the large blocks of solid yellow sulfur and the loading **18**

docks are interesting sights and photography subjects. Ten miles downriver from Port Sulphur is Empire, a center for deep-sea fishing charter boats, and 10 miles farther downriver is an interesting brick fort, Fort Jackson. The guns at Fort Jackson commanded a large bend in the Mississippi River around which sailing vessels had to tack, thus affording easy shots from the fort (map location 19). Admission is free.

19

Twelve miles farther downriver, about 3 miles past Venice, is the end of the highway. Gulf Oil Corp. has a refinery at this location (map location 20). From this point, the traveler can only retrace his steps back upriver toward New Orleans. Approximately 10 miles upriver from the Pointe-a-la-Hache ferry landing, Gulf Oil Corp. has one of the newest and most modern petroleum refineries in the United States at Myrtle Grove (map location 21). The refinery is approximately 30 miles from downtown New Orleans.

20

21

U.S. 61—New Orleans to Baton Rouge.—Between New Orleans and Baton Rouge along the Mississippi River are a large Shell Oil Co. refinery and a very large alumina plant of Kaiser Aluminum Co., numerous petrochemical plants, as well as many old plantation homes that the tourist may visit. (Travelers interested in the ante bellum homes should inquire further as most of them are along the Old River Road.) Approximately 20 miles from downtown New Orleans at Norco is the large Shell Oil Co. refinery. Just north

Giant stockpiles of bright yellow sulfur at Port Sulphur.

Gulf Oil Co. refinery south of Venice, La.

of Norco, the highway crosses the Bonnet Carre spillway. During times of high water in the Mississippi River, spillway gates may be opened to allow a portion of the river water to flow directly into Lake Pontchartrain, thus decreasing flooding potential in the City of New Orleans, much of which lies below sea level.

At Gramercy, approximately 35 miles from New Orleans, is a Kaiser Aluminum & Chemical Corp. alumina plant (map location 15). The plant is south of the highway. It borders the Mississippi River and is in a sugarcane growing area. From the highway, the plant appears to be set in a sugarcane field. **15**

The area along the Mississippi River between New Orleans and Baton Rouge has developed into a major center for petrochemical, refining, and related industries. This has been due to the abundance of water, cheap water transportation and, until about 1973, the abundance of natural gas and petroleum for fuel and raw material. The Geismar area is a prime example of this development (map location 22). **22**

At Sorrento, approximately 45 miles from New Orleans on U.S. 61, turn left on La. 22 for about 8 miles to Darrow. Take La. 75 upriver to the small town of Geismar. Petrochemical plants in the Geismar area include Air Products and Chemicals Inc., Allied Chemical Corp., BASF—Wyandotte Corp., Borden Inc. Chemical Div., Monochem Inc., Morton Chemical Co., Rubicon Chemicals Inc., Shell Chemical Co., Uniroyal

Chemical Div., and Vulcan Materials Co. Chemicals Div.

At Geismar turn right at La. 73 for approximately 7 miles to return to U.S. 61 at Prairieville, and continue on to Baton Rouge, the State Capitol.

U.S. 190—Baton Rouge.—At the Mississippi River in northwest Baton Rouge, on the east bank of the river north of the highway, is the large Ideal Cement plant (map location 12). It was shut down in 1975. Oyster and clam shells were barged to the location and calcined into lime to be used in making cement. Just south of the highway, also on the east bank of the river, is the Baton Rouge alumina plant of Kaiser Aluminum & Chemical Corp. (map location 13). Bauxite ore from Jamaica is unloaded at these docks and processed into alumina. Immediately south of the Kaiser plant is the Exxon USA Baton Rouge refinery —largest in the United States and one of the largest in the world (map location 14).

12

13

14

At the Conalco plant south of Lake Charles, pigs of aluminum are stacked in the parking lot.

U.S. 190—Erwinville.—Fifteen miles west of Baton Rouge on the south side of the highway is the Big River Industries lightweight aggregate plant (map location 23). Clay from local pits is "bloated" by heating in rotating kilns. Lightweight aggregate is formed. It is sized and used in place of gravel in making concrete, to be used where lightweight concrete would be advantageous, as in the floors of tall buildings.

23

Interstate 10, U.S. 90.—Approximately 2 miles west of Sulphur Interstate 10 passes 2 miles south of Sulphur salt dome (map location 1). (U.S. 90 passes 1 mile south of the dome.) This was the original site where Dr. Herman Frasch developed the Frasch sulfur mining process. (See Historical Sites)

1

Interstate 10, La. 108.—Four miles west of the Calcasieu River Bridge at Lake Charles turn off Interstate 10 to the south on La. 108. This road leads directly to an intensive industrial plant area (map location 2).

2

Plants include Hercules, Cities Service (refinery—lube oil plant—butyl rubber plant—petrochemical plant), Firestone Tire & Rubber Co., and Davison Chemical Div. of W.R. Grace & Co.

On Interstate 10 just west of the aforementioned Calcasieu River Bridge are Olin Mathieson Chemical Corp., W.T. Burton Co., Continental Black Inc., Ancon Chemical Corp., and Continental Oil Co. plants.

The Consolidated Aluminum Corp. (CONALCO) reduction plant is south and west of Lake Charles (map location 3). One of the main north-south streets is Ryan Street. Go south on Rvan Street until it turns to the west and becomes La. 384. Follow La. 384 west 3½ miles where it turns south. Go south 3¼ miles to the turnoff into the Conalco plant. 3

Interstate 10—Jennings.—Thirty-one miles east of Lake Charles is Jennings—the birth place of the Louisiana oil and gas industry (map location 4). (See Historical Sites) 4

U.S. 90—Lafayette.—In Lafayette, Heymann Oil Center is located 1 mile southwest of U.S. 90 on Pinhook Street (map location 5). This is an area of approximately 10 square blocks devoted to offices for most of the major producing companies, drilling companies, and supply companies of the petroleum industry. Much of the offshore industry is supervised from offices in this area. The District Conservation Commission Office is in the Oil Center. 5

U.S. 90—New Iberia.—South of Lafayette approximately 20 miles is the beautiful Bayou Teche Country and New Iberia, a center for rock salt mining. The Five Islands (salt domes) stretch in a straight line from Jefferson Island, just west of New Iberia; Avery Island, just south of New Iberia; Weeks Island, southeast of New Iberia; West Cote Blanche Bay Island, southwest of Franklin; and Belle Isle, southwest of Morgan City on the coast. These are elevated "islands" pushed up above the surrounding low-lying coastal marshes by intrusive salt domes. These intrusive salt stocks, greater than a mile in diameter, rise from a mother salt bed that is probably 50,000 feet deep, and each of the "five islands" is mined for rock salt. Salt mines are tremendous operations with mile after mile of very large rooms where salt has been excavated. It is hard to visualize the quantity of salt that has been removed from these five mines. Safety and insurance requirements preclude tourist tours of these facilities; however, both Jefferson Island and Avery Island have other tourist attractions in the form of gardens and bird sanctuaries. These two islands, along with Weeks Island, are especially beautiful spots.

Jefferson Island.—At New Iberia, this salt dome is 6 miles west of U.S. 90 on La. 14. This is the site of

6 the Diamond Crystal Salt Co. Jefferson Island mine (map location 6).

Avery Island.—At New Iberia, turn off U.S. 90 on La. 329. Go southwest on La. 329 for 7 miles to the tollgate entrance to Avery Island bird sanctuary and scenic gardens. This is the site of International Salt Co. Avery Island mine (map location 7).

7

Weeks Island.—At New Iberia turn off U.S. 90 onto La. 83. Go 13 miles south to the entrance to Weeks Island. This is the site of Morton Salt Company Weeks Island mine (map location 8).

8

West Cote Blanches Bay Island.—Go 6 miles east southeast from Weeks Island on La. 83. Turn south 1 mile to a ferry over the intracoastal canal. One mile south is the site of Domtar Chemicals, Inc., Cote Blanche mine (map location 9). It can be reached by car, but it is not recommended.

9

Belle Isle.—About 25 miles further to the southeast, Belle Isle can be reached only by boat. It is the site of Cargill Salt Co. Belle Isle mine (map location 10). The Cargill office is on the southeast bank where U.S. 90 degrees Wax Lake Outlet at Calumet (just west of Patterson).

10

U.S. 90.—At Morgan City, just south of the bridge over the Atchafalaya River, are large piles of oyster and clam shell dredged from the lakes and bays in the area. More oyster and clam shells may be seen south of the highway just east of Morgan City at the Pelican lime plant (map location 11). Here the shells are calcined in rotating kilns and converted into lime. Morgan City is also a center for the offshore petroleum industry and the site where many offshore platforms are fabricated. East of Morgan City and east of the Pelican lime plant is a good view of the J. Ray McDermott fabricating plant.

11

La. 8—Gravel Pit.—At Pollock, 15 miles north of Alexandria, leave U.S. 165. Go east and north on La. 8 approximately 4 miles. About 1 mile beyond the small village of Fishville is an area of gravel pits (map location 24). There are several similar areas—northeast of Baton Rouge, south of Bogalusa, northeast and southwest of Alexandria, near Shreveport, and near Monroe. This one was picked as a good example.

24

U.S. 84—Quarry.—Five miles west of Winnfield is the abandoned Morton Salt Co. mine. The mine became flooded in about 1965 and was abandoned (map location 25). The cap rock of this intrusive salt dome is quarried at a site near the abandoned salt mine. This is the only active stone quarry in Louisiana.

25

Sand and gravel operation at Fishville, La.

MINES YOU CAN VISIT

The only underground mines in Louisiana are the previously mentioned "Five Islands" salt mines. Due to stringent federal health and safety regulations and due to insurance regulations, none of them are open to visitors. Sulfur mines, although commonly called "mines", are really wells with multiple concentric strings of casing through which hot water is injected to melt sulfur, and the melted sulfur is forced to the surface. Sulfur mine sites are all inaccessible by auto. The Grande Isle offshore sulfur mine structure may be seen with binoculars from Grande Isle beach.

HISTORICAL SITES

A historic mining spot is west of Lake Charles at the Sulphur Mine dome where Dr. Herman Frasch successfully mined sulfur in 1894 by a unique hot water melting process after several attempts to use conventional mining processes had failed. The Union Sulphur Corp., which Dr. Frasch helped organize here, produced the world's first Frasch process sulfur in 1895. The actual site of this operation was 2 miles west of the town of Sulphur.

Oil was first discovered in Louisiana near Jennings. A historical plaque and a replica of the well have been erected in Jennings to commemorate this event. For the tourist, an early-day French Acadian (or "Cajun") house museum is also present on the site.

FOR MORE INFORMATION WRITE OR VISIT

Federal Bureau of Mines Liaison Office, Room 119, Federal Courthouse Building, 707 Florida Street, Baton Rouge, La. 70801.

Louisiana State Department of Conservation, P.O. Box 44275, Baton Rouge, La. 70804.

Louisiana Tourist Development Commission, P.O. Box 44291, Baton Rouge, La. 70804.

State Geologist, Louisiana Geological Survey, Department of Conservation, University Station, Box G, Baton Rouge, La. 70803.

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MISSISSIPPI

by
Henry P. Wheeler, Jr., and John L. Reuss

The minerals resources of Mississippi are not readily apparent to a visitor traveling the highways because they are mostly obscured by the natural beauty of the State's forests, fields, pastures, rivers and lakes. The benefits derived from these resources are much more apparent than the resources themselves—in the highways and buildings constructed with minerals products, and in the diverse forms of energy so vital to the comfort, mobility, and well-being of Mississippians and visitors alike.

The old and famous Natchez Trace Road between Natchez and Nashville is a deep and narrow rut along much of its length, where horses and wagons eroded the soil. The new Natchez Trace Parkway is modern and paved with concrete. This contrast is typical in Mississippi. The antebellum homes and the traditional southern hospitality are still here, and agriculture continues to be important in Mississippi, but there is also much that is new and exciting. Today, there are more than 2000 manufacturing establishments in the State, and there are more workers employed in manufacturing than in agriculture.

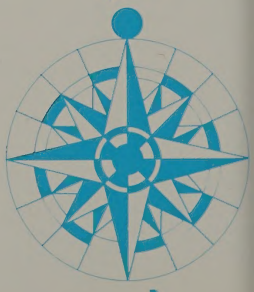
Mississippi ranks about midway among the States in value of mineral production. In the mid-1970's, the value of minerals production in Mississippi was about a half a billion dollars. Petroleum and natural gas were the principal contributors with sand, gravel, clays and limestone accounting for most of the remainder. Some sulfur is extracted from natural gas produced in the State. Mississippi ranks ninth among the States in the production of petroleum and 12th in the production of natural gas. As of April 30, 1975, there were 435 oil and gas fields in Mississippi with 3,029 producible wells.

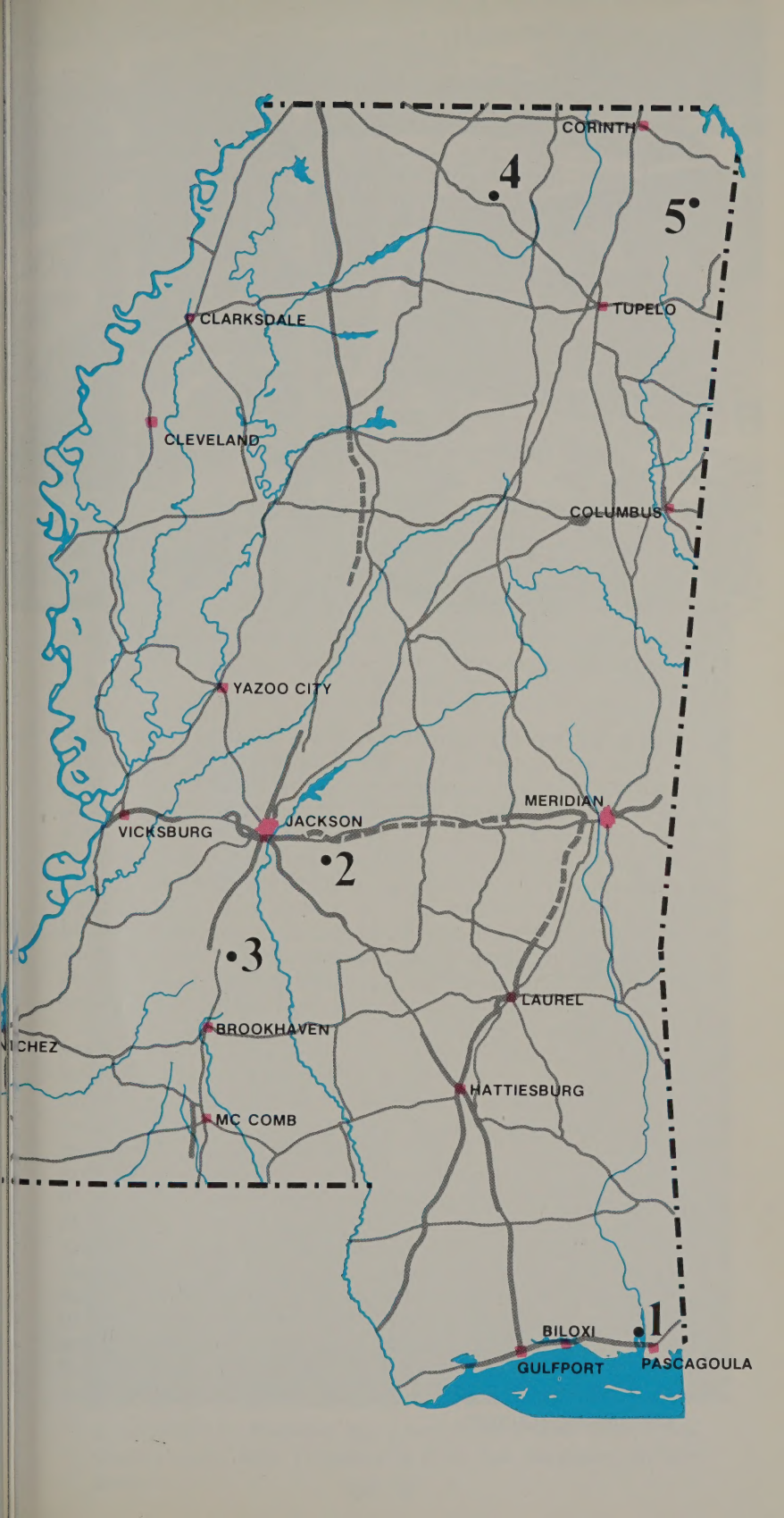
The State has five petroleum refineries; the largest is operated by the Standard Oil Co. of Kentucky near Pascagoula, Miss. (map location 1). There are two cement plants and a number of brick and tile plants in Mississippi. Electric power is generated and distributed principally by the Mississippi Power Co. in

1

LEGEND

1— Large petroleum refinery
2— Sulfur extraction plant
3— Sand and gravel pits
4— Historic iron furnace
5— Woodall Mountain

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TUPELO
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YAZOO CITY
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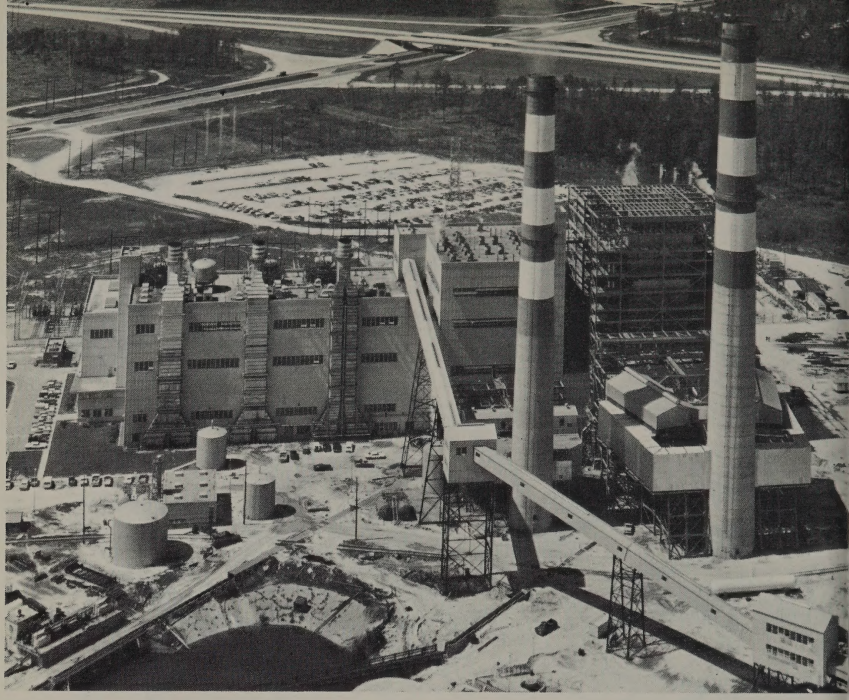


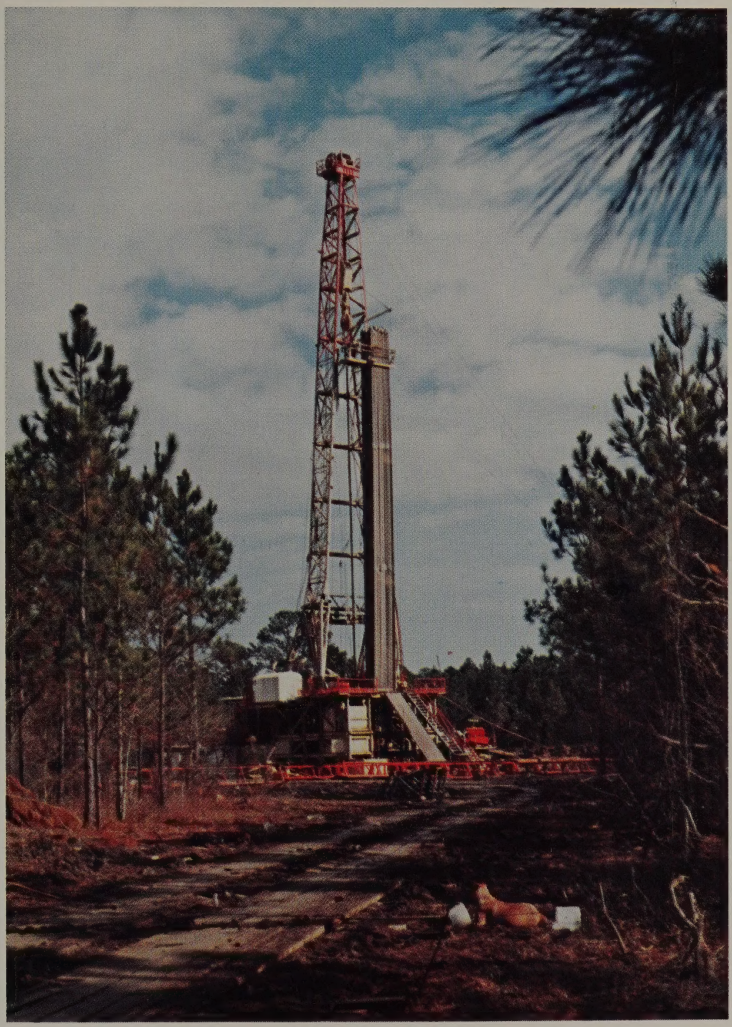
Mississippi Power Co.'s Plant Watson, located between Gulfport and Biloxi. (Courtesy of Hinman Advertisers.)

the southern portion of the State and by Mississippi Power and Light Co. in the remainder. A new sulfur extraction plant is operated by the Shell Oil Co. near
2 Brandon in Rankin County (map location 2). Sand, gravels, and clays are mined in 30 of the State's counties. Some of the larger operations are south of
3 Jackson, in the vicinity of Crystal Springs and Hazlehurst (map location 3). Visitors are welcome at most, if not all, of these facilities, but arrangements should be made in advance by contacting the plant superintendents. The facilities are listed in the yellow pages of local telephone directories, and many of the companies have offices in Jackson.

Some of the mineral resources of Mississippi are relatively untouched—awaiting the technological developments and economic conditions that could make them valuable. Iron ore was mined in Clarke County as early as 1887 and in Kemper County as late as 1969; a small smelter near Winborn in Benton County reportedly produced 125 tons of pig iron in
4 1913 (map location 4). Lignite, a form of coal, has been mined at various times since the 1920's in Choctaw and Winston Counties. Some other potentially valuable mineral resources include salt from the Richton dome in Perry County and many other salt domes in the State, heavy minerals such as titanium in the beach sands on the islands off the Mississippi gulf coast, and bauxite, the principal ore from which aluminum is obtained.

The highest elevation in Mississippi (806 feet above sea level) is Woodall Mountain near Iuka in the northeast corner of the State (map location 5). Here too, in Tishimingo County, are found the oldest exposed rock formations in the State (Devonian—about 400 million years). From east to west, and from north to south, the exposed rock formations become progressively more recent in geologic time—reaching the flat Mississippi alluvial plain known as the Delta—south of Memphis and north of Vicksburg on the west, and the coastal plains dipping gently into the Gulf of Mexico on the south. Only in the Delta and in the coastal plains is the land as flat as might be expected by a visitor to the State. The average elevation in Mississippi is 300 feet above sea level.

5



Inexco Oil Co. Masonite No. 1 well in the Prairie Branch field, Clark County, Miss. (Courtesy of R. E. Lee Associates, Jackson, Miss.)

Bordering the Delta on the east and continuing along the Mississippi River south of Vicksburg, there is an interesting geological formation comprised of gray to tan silt known as loess. It is thought that loess is rock flour, ground and reground by glacial action in the northern part of North America and transported southward by glacial waters. When dry, it was blown by the wind into its present location. The loess formation is characterized by steep, almost vertical, walls along highways and streams in the region where it is found.

Mississippi has achieved its goal of balancing agriculture with industry through good planning, a good work force, investment incentives, and with its abundant supply of natural minerals and fuels resources.

South portion of old Natchez Trace near Natchez, Miss. (Courtesy of National Park Service.)

FOR MORE INFORMATION WRITE OR VISIT

Federal Bureau of Mines Liaison Office, Room 408, 301 Building, 301 North Lamar Street, Jackson, Miss. 39202.

Director, Mississippi Agricultural and Industrial Board, Walter Sillers State Office Building, Jackson, Miss. 39202.

Director, Mississippi Geological, Economic, and Topographical Survey, 2525 North West Street, Jackson, Miss. 39216.

Secretary, Mississippi Economic Council, Standard Life Building, Jackson, Miss. 39201.

Supervisor, Mississippi Oil and Gas Board, Woolfolk State Office Building, Jackson, Miss. 39202.

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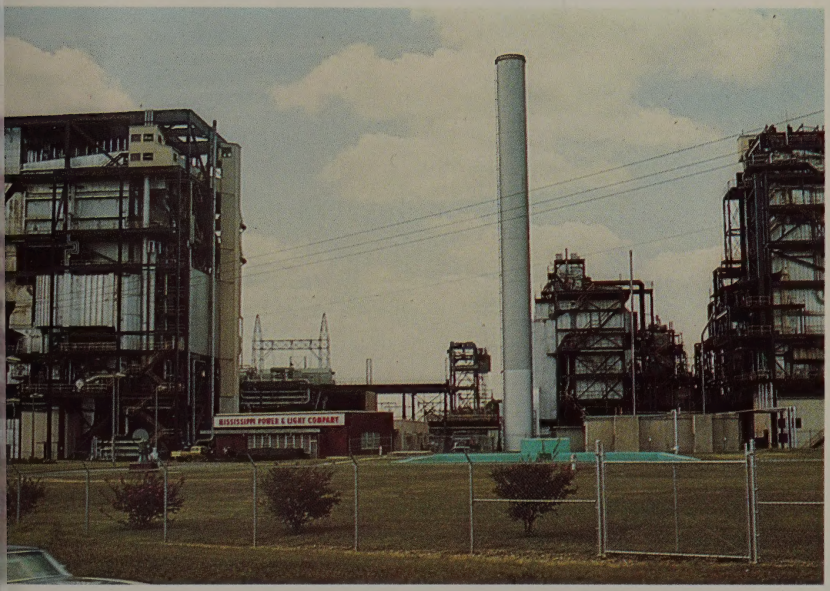


Rex Brown generating plant. (Courtesy of Mississippi Agricultural and Industrial Board.)

Quarry in Goodland Limestone of Cretaceous age worked by Idabel Stone Co. on U.S. 70 near Idabel, McCurtain County, to produce

OKLAHOMA

by
Robert H. Arndt

The mineral industry is the largest stone in the foundation of Oklahoma's economy. The value of $2.3 billion for produced minerals far exceeded the value of any other of the State's products in 1975. About 96 percent of the mineral industry value was derived from the production of crude oil, natural gas, helium, and associated products of the petroleum industry. The remainder, totaling $120 million, was the result of mining essentially solid mineral substances and preparing mineral-derived substances. Minerals that were mined in 1975 were clay, copper, feldspathic sand, gypsum, salt, sand and gravel, silver, stone, tripoli and volcanic ash. Cement and lime were prepared from mined mineral substances.

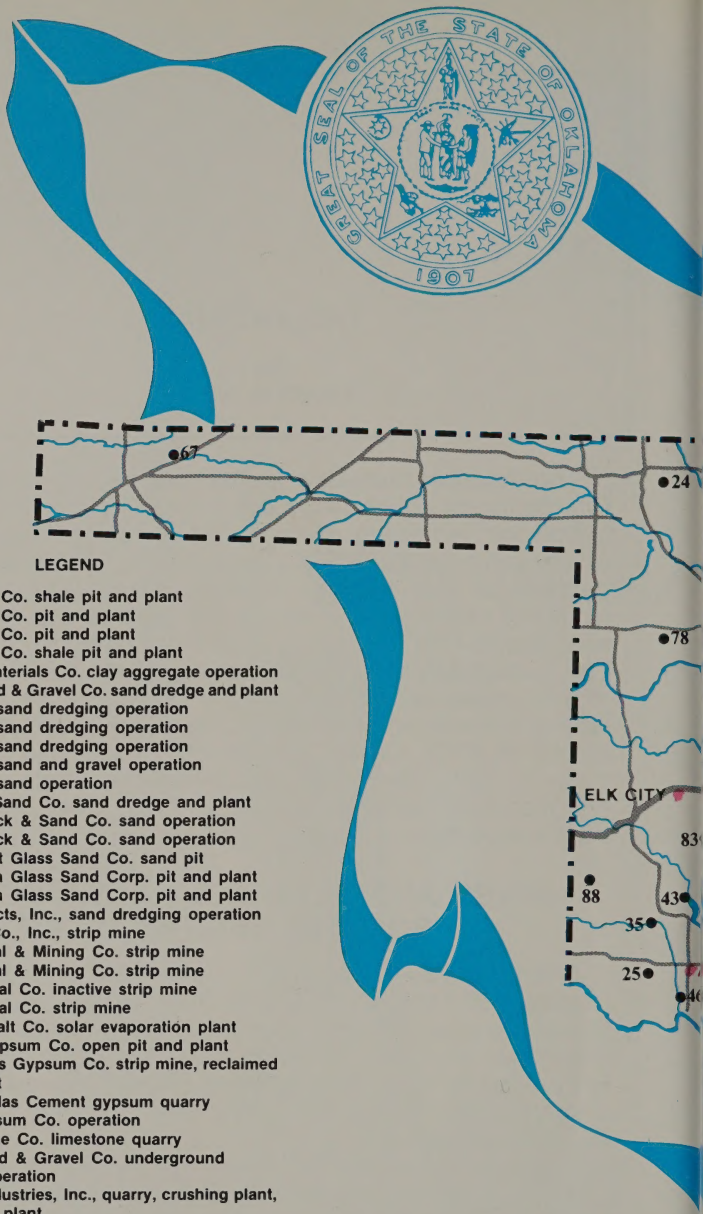
MINES AND PLANTS YOU CAN SEE FROM THE HIGHWAYS

Interstate 35.—In Murray County, dust occasionally reveals the position of the Sooner Rock & Sand Co. limestone quarry 1 mile southwest of the Davis exit off Interstate 35 (map location 33). Limestone of the Fernvale and Viola (Ordovician) strata are crushed in a stationary plant at the quarry site to supply various types of aggregate. 33

The Rayford quarry of Dolese Bros. Co. in Murray County is briefly visible east of the highway about 5 miles south of the Davis exit (map location 59). Sylvan-Viola limestone of Ordovician age is quarried for construction aggregate. 59

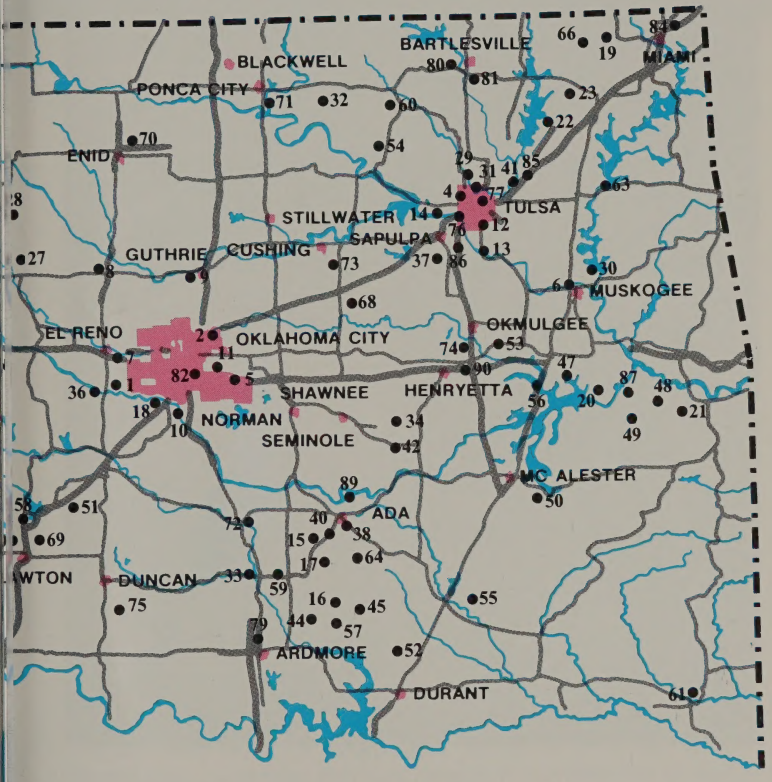
Interstate 35, Interstate 40.—Oil well derricks that are visible north and south of Interstate 35-Interstate 40 in central Oklahoma City display the broad extent of the Oklahoma City oilfield, which was discovered in 1929. Producing wells on the grounds of the State Capitol in the north-central part of the city symbolize the influence of the petroleum industry in the development of the State (map location 82). 82

Interstate 35, U.S. 77.—Additions to the Kerr-McGee Corp. refinery on the south edge of Wynne-



LEGEND

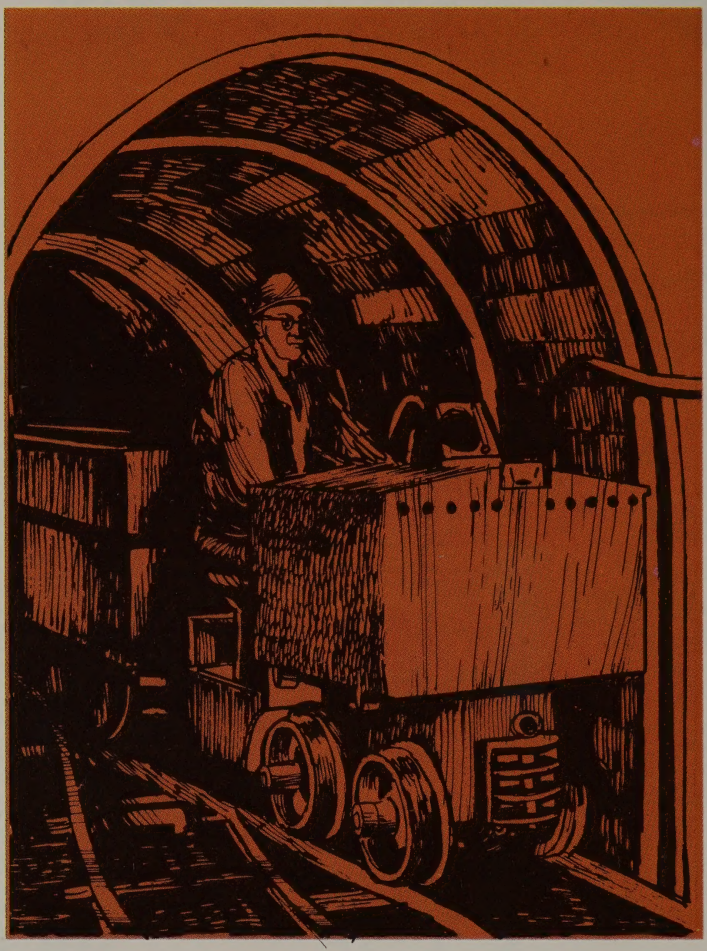
1— Acme Brick Co. shale pit and plant
2— Acme Brick Co. pit and plant
3— Acme Brick Co. pit and plant
4— Acme Brick Co. shale pit and plant
5— Chandler Materials Co. clay aggregate operation
6— Arkhola Sand & Gravel Co. sand dredge and plant
7— Dolese Co. sand dredging operation
8— Dolese Co. sand dredging operation
9— Dolese Co. sand dredging operation
10— Dolese Co. sand and gravel operation
11— Dolese Co. sand operation
12— McMichael Sand Co. sand dredge and plant
13— Mohawk Rock & Sand Co. sand operation
14— Mohawk Rock & Sand Co. sand operation
15— Midcontinent Glass Sand Co. sand pit
16— Pennsylvania Glass Sand Corp. pit and plant
17— Pennsylvania Glass Sand Corp. pit and plant
18— Sand Products, Inc., sand dredging operation
19— Bill's Coal Co., Inc., strip mine
20— Garland Coal & Mining Co. strip mine
21— Garland Coal & Mining Co. strip mine
22— Peabody Coal Co. inactive strip mine
23— Peabody Coal Co. strip mine
24— Blackmon Salt Co. solar evaporation plant
25— Republic Gypsum Co. open pit and plant
26— United States Gypsum Co. strip mine, reclaimed land, and pit
27— Universal Atlas Cement gypsum quarry
28— Walton Gypsum Co. operation
29— Anchor Stone Co. limestone quarry
30— Arkhola Sand & Gravel Co. underground limestone operation
31— Standard Industries, Inc., quarry, crushing plant, and hot mix plant
32— Standard Industries, Inc., limestone quarry
33— Sooner Rock & Sand Co. limestone quarry
34— United Clay Pipe Co. mine and plant
35— Mangum Brick Co. pit and plant
36— Oklahoma Brick clay and cement brick plant and pit
37— Sapulpa Brick & Tile Corp. brick plant and pit
38— Superior Clay Products, Inc., brick plant and pit
39— Dolese Bros. Co. limestone quarry
40— Ideal Cement Co. limestone quarry
41— Martin Marietta Cement Co. plant
42— Commercial Brick Corp. plant
43— Fairfax Granite Co. quarries and monument works
44— Boadie Anderson Quarries granite quarries
45— Century Granite, Inc., inactive granite quarry
46— Eagle-Picher Industries, Inc., inactive copper and silver strip mine
47— Carbonex Coal Co. strip mine
48— Paul Rees Coal Co. strip mine
49— Lone Star Steel Co. inactive strip mine and reclaimed land
50— Lone Star Steel Co. inactive coal strip mine
51— Harrison Gypsum Co. operation
52— Bryan County Limestone Co. quarry
53— George Cummins Construction Co. lime quarry
54— Leco Materials, Inc., limestone quarry
55— Stringtown Materials Inc. limestone qua
56— H. D. Youngman limestone quarry and c plant
57— Delta Mining Corp. dolomite mill and q
58— Temple Gypsum Div. of Temple-Eastex quarry
59— Dolese Bros. Co. limestone quarry
60— Blake Stone Co. limestone quarry
61— Idabel Stone Co. limestone quarry
62— Fairfax Granite Co. quarry
63— Oklahoma Cement Co. plant and limest quarry
64— C & O Materials, Inc., limestone quarry
65— Roosevelt Granite Co. Inc. quarry
66— O'Brien Rock Co., Inc., limestone quarr
67— Federal Bureau of Mines helium operati
68— Allied Materials Corp. crude oil refinery
69— Apco Oil Corp. crude oil refinery



- Champlin Petroleum Co. crude oil refinery
- Continental Oil Co. crude oil refinery and research center
- Kerr-McGee Corp. crude oil refinery
- Midland Cooperatives, Inc., petroleum refinery
- OKC Refining, Inc., crude oil refinery
- Sun Oil Co. DX Div. crude oil refinery
- Sun Oil Co. DX Div. crude oil refinery
- Texaco Inc. refinery
- Tonkawa Refining Co. crude oil refinery
- Vickers Petroleum Corp. refinery
- Cudahy Oil Co. No. 1 Nellie Johnstone oil well
- National Zinc Co. smelter
- Oklahoma City oilfield
- Lone Star Producing Co. No. 1 Bertha Rogers
- Tongaha Mining Co. tourist zinc mine
- Tulsa Port of Catoosa, head of the McClellan-Kerr Arkansas River Navigation System
- Frankoma Pottery, Inc., plant
- Garland Coal & Mining Co. coal loading point
- Acme Salt Co. solar evaporation plant
- Ideal Cement Co. plant
- P & K, Ltd., coal shipping point

wood will increase its refining capacity to 64,000 barrels of crude oil per day by 1976 (map location 72). The company takes pride in the high quality of water released from the refinery and the installed air pollution control measures.

72



In Carter County, the Vickers Petroleum Corp. refinery, 2.5 miles east of Interstate 35 from the Okla. 142 exit at Ardmore and 2 miles east of U.S. 77, will have refining capacity for 60,000 barrels of oil per day by 1975 after completion of a new addition (map location 79).

79

Interstate 40.—This highway is almost devoid of any active mining or mineral activity. Unreclaimed or orphan coal strip pits are visible south of the highway in the vicinity of Sallisaw, locally between Warner and Checotah, and several miles east of Henryetta north of the highway.

Strip mining by Peabody Coal Co. on U.S. 66 near Chelsea, Rogers County, Okla. From left to right are undisturbed land, a strip pit, spoil piles, and leveled spoil ready for revegetation. (Courtesy of Oklahoma Geological Survey.)

U.S. 60.—Fifteen miles west of Vinita in Craig County, coal is strip mined both north and south of U.S. 60 by Peabody Coal Co. (map location 23). Some of the lands were mined before the enactment of a State law requiring reclamation of strip mines; consequently, much of that land lies in massive ridges and furrows left from mining. Since 1971, disturbed lands have been reclaimed after mining, leaving a rolling surface that has been revegetated. Coal from these mines is shipped by unit train to the vicinity of Kansas City, Mo., for use in generating electricity. 23

On Okla. 123 south of U.S. 60 in Bartlesville is the National Zinc Co. of Oklahoma smelter. The smelter, originally a horizontal retort plant that was modified over a considerable number of years to improve plant efficiency and control pollution, was being rebuilt as an electrolytic plant in 1975 (map location 81). This is the only zinc smelter in Oklahoma that survived the demise of mining in the Tri-State zinc-lead district and the onslaught of antipollution regulations between 1965 and 1975. 81

One mile west of Pawhuska, south of U.S. 60, Blake Stone Co. quarries the LeCompton Limestone of Late Pennsylvanian age for road surface treatment (map location 60). 60

West of the intersection of U.S. 60 with Okla. 18 near Burbank, Red Eagle Limestone of Permian age is mined by Standard Industries, Inc., for aggregate and jetty riprap (map location 32). 32

U.S. 60, U.S. 77.—The Continental Oil Co. refinery and research center is located in the southern part of Ponca City (map location 71). The refinery has the capacity to process 117,000 barrels of crude oil per day, making it not only the largest refinery in Oklahoma, but also the largest refinery operated by Continental Oil Co. 71

U.S. 62.—Two miles north of Fort Gibson on Okla. 80 west of U.S. 62, Arkhola Sand & Gravel Co. mines limestones of the Pitkin and Boyd Formations in underground workings (map location 30). The product is aggregate, dense road base, and jetty riprap.

30

Four miles west of Harrah, north of U.S. 62, expanded clay aggregate is the product of Chandler Materials Co., which strip mines alluvium from the bottoms of Choctaw Creek (map location 5). The aggregate is sold mostly in the vicinity of Oklahoma City.

5

Four miles west of Nicoma Park, north of U.S. 62, the Dolese Co. recovers sand from alluvium deposits of the North Canadian River (map location 11).

11

Aside from passing numerous established and developing oil and gas fields, U.S. 62 also skirts several sites where construction materials, including sand and gravel, limestone, granite, and gypsum, are mined. Seven miles south of the Oklahoma City south bypass, Sand Products, Inc., pumps and dredges sand from the riverbed and alluvium of the South Canadian River (map location 18). One mile north of Newcastle, east of U.S. 62, the Dolese Co. strip mines sand and gravel (map location 10).

18

10

At Richards Spur, west of U.S. 62, extensive quarries produce large quantities of Upper Arbuckle Limestone of Ordovician age. The limestone is crushed and sent by unit train to central and north-central Oklahoma for construction aggregate (map location 39). Other uses for the limestone are riprap, railroad ballast, and dense road base. The quarries at Richards Spur were established about 1908 to provide railroad ballast for the Chicago Rock Island & Pacific Railroad and later became the property of the Dolese Brothers.

39

Most of the massive hills of the Wichita Mountains seen west of Lawton and the numerous smaller hills protruding from a generally level plain as far west as Granite in Greer County are granite. Quarries are easily recognized at a distance by masts and booms of derricks used to move blocks of stone. The quarry of Fairfax Granite Co., 4 miles north from Business U.S. 62 in Snyder on U.S. 183, is a source of monument stone that is distributed through Rock of Ages, Barre, Vt. (map location 62).

62

The quarry of Roosevelt Granite Co. Inc., 4 miles west of the U.S. 183-Business U.S. 62 intersection and 1.5 miles northwest of U.S. 62, is visible on Long Mountain (map location 65). The product is monument stone distributed independently in Oklahoma and other States.

65

On Okla. 34, 1.5 miles south of U.S. 62 at Duke, Republic Gypsum Co. mines gypsum from the Blaine

Solar evaporating pans used by the Acme Salt Co. to produce solar salt from salt brine. The pans are located on Okla. 30 in Harmon County. (Courtesy of Oklahoma Geological Survey.)

Formation of Permian age in an open pit (map location 25). The associated plant, 0.5 mile west of Duke, manufactures sheathing for construction use. 25

U.S. 64.—Near the Arkansas River 1 mile west of U.S. 64, Mohawk Rock and Sand Co. recovers sand from the bed of the Arkansas River and associated alluvial deposits on the west bank of the river north of Bixby (map location 13). 13

Blackmon Salt Co. produces salt from wells in the Flowerpot Shale of Permian age by solar evaporation of salt brine. The operation is on Big Salt Plain in the floodplain of the Cimarron River, 3 miles south and 2 miles west of Plainview, where the tops of salt beds range from 30 to 138 feet below the surface (map location 24). Natural brine that is pumped from wells drilled 40 to 100 feet deep is evaporated in surface pans. Salt that crystallizes from the evaporating brine is collected by scrapers. It is reported as 99.2 to 99.8 percent sodium chloride. The salt is sold for stock feed, water softener recharger, and street ice remover. Brine is used as drilling fluid in drilling for oil and natural gas. 24

U.S. 66.—Between Vinita and Catoosa just east of Tulsa, U.S. 66 follows closely the outcrop traces of the principal coalbeds that are mined in northeastern Oklahoma. Strip mining in the near-surface parts of the coals has created an almost continuous band of disturbed land on the northwest side of the highway. Much of the coal was mined after 1915 and before the first State strip mine reclamation law of 1968. As a consequence, little of the visible mined land has been reclaimed.

For several years, Peabody Coal Co. has been mining as many as three coalbeds at a distance 3 to 5 miles west of U.S. 66 and 1 mile south of Chelsea

United States Gypsum Co. strip pit at Southard in Blaine County. The land was stripped with bulldozers and scrapers to expose the Blaine Gypsum.

22 (map location 22). Most of the coal is used to generate electricity in the vicinity of Kansas City, Mo., but an appreciable quantity is suitable for preparing coke used in the iron and steel smelting industry. Much of Peabody's mined land has been reclaimed under State law.

85 Tulsa Port of Catoosa, 1.5 miles north of Catoosa, is the head of navigation of the McClellan-Kerr Arkansas River Navigation System (map location 85). In 1973, coal was shipped downstream by barge from the port.

68 Allied Materials Corp. operates a refinery with a capacity of 4,000 barrels of crude oil per day on the east side of Stroud (map location 68).

Although the routes traversed by U.S. 66 and Interstate 40 pass only a few mining operations for solid minerals, they do cross diagonally over the Anadarko Basin, which is considered by many to be potentially one of the Nation's future great natural gas fields. The masts of drilling rigs are common sights throughout the area. In the daytime, the drilling rigs look like skeletal towers; at night, brightly lighted by strings of electric bulbs, they are visible in the broad rolling plains for many miles. Exploratory drilling has already penetrated underlying strata to a depth of more than 30,000 feet and found producible natural gas at a depth of more than 25,000 feet.

7 In Canadian County, 9 miles west of Lake Overholser, north of U.S. 66, the Dolese Co. dredges sand from alluvium of the North Canadian River (map location 7).

U.S. 66, Okla. 33.—The Arkansas River is a prolific source of sand for Tulsa's construction industries. The McMichael Co. sand plant on the west bank of the river, 0.5 mile north of the Skelly Drive bridge, is but one of a number of plants that pump sand from the riverbed in a stretch of about 3 miles upstream from the bridge (map location 12).

12

Sapulpa Brick and Tile Corp. and Frankoma Pottery, Inc., extract clay and shale from the Coffeyville Formation of Pennsylvanian age in pits south of U.S. 66 in the western part of Sapulpa (map locations 37, 86). Sapulpa Brick and Tile manufactures only brick. Frankoma Pottery, Inc., manufactures pottery, including dinnerware, florist items, and artware. Visitors are welcome to visit Frankoma's plant; see details in the section "Mines and Plants You Can Visit."

37

86

U.S. 69.—South from the Kansas State line to Miami, U.S. 69 traverses the Oklahoma part of the Tri-State zinc-lead district, which was at one time the Nation's foremost source of zinc. The mines were closed about 1970, and surface installations have been dismantled. Today the only evidences of the former extent of mining are tailings ponds from the ore mills, chat piles, and surface depressions. The chat piles are diminishing as chat is sold for road surfacing and railroad ballast material as well as for other special applications. Surface depressions are commonly the upper manifestation of underground caving in old mine shafts and workings. Picher, Cardin, and Commerce have experienced serious local caving problems.

Drilling rig on Lone Star Producing Co. No. 1 Bertha Rogers located on Okla. 152 near Burns Flat in Washita County. An influx of molten sulfur filled the bottom of the hole back to drilling depth of about 14,000 feet and prevented chances of successful completion as a producing gas well. (Courtesy of Oklahoma Geological Survey.)

6 On the south bank of the Arkansas River 2 miles north of the Muskogee city limits, Arkhola Sand & Gravel Co. extracts sand from the bed of the Arkansas River by pumping (map location 6). Sand is prepared at the plant for a variety of uses in construction and for use in manufacturing glass locally. Feldspathic sand (about 25 percent feldspar, 75 percent quartz) is one of the chief products.

56 Six miles south of Checotah, east of U.S. 69, H. D. Youngman, Contractor, quarries and crushes limestone at a permanent plant (map location 56). the product is used as concrete and asphalt aggregate.

55 One mile north of Stringtown, east of U.S. 69, interbedded limestone and chert is quarried from Ordovician strata by Stringtown Materials, Inc. (map location 55). Crushed limestone is used as railroad ballast and aggregate. Products are shipped as far as Houston, Tex., and St. Louis, Mo. At Stringtown, the Ti Valley fault, a major structural feature of the Ouachita Mountains, separates strata of Ordovician age on the southeast from strata of Pennsylvanian age on the northwest, along a line approximately parallel to the highway.

U.S. 70.—Goodland Limestone of Cretaceous age is quarried south of Little River, west of U.S. 70, by Idabel Stone Co. for use as agricultural limestone (map location 61). Crusher and stone stockpiles are visible from the highway. 61

U.S. 75.—The northern segment of U.S. 75 from the Kansas State line to Henryetta displays mainly activities of the petroleum industry. At Henryetta, one can see unreclaimed coal strip mines and waste piles from a former zinc smelter east of U.S. 75.

To the west of U.S. 75, Interstate 244 south of the Arkansas River is the Sun Oil Co. petroleum refinery. The refinery has a capacity to process 87,000 barrels of crude oil per day (map location 76). This establishes it as the second largest refinery in Oklahoma. 76

To the east of U.S. 75, Interstate 244 south of the Arkansas River, the Texaco, Inc., refinery has a capacity to refine 51,000 barrels of crude oil per day (map location 77). 77

OKC Refining, Inc., which can be seen at the north end of Okmulgee west of U.S. 75, can process 20,000 barrels of crude oil per day (map location 74). 74

North of Henryetta, east of U.S. 75, P & K, Ltd., operates a coal shipping point on abandoned grounds of a zinc smelter that was dismantled in the early 1960's (map location 90). Unreclaimed coal strip mines lie to the southeast. South of Henryetta only the unreclaimed coal strip mines between Coalgate in Coal County and Atoka in Atoka County are prominent. This is in the southernmost extension of Oklahoma's coal belt. 90

U.S. 77.—One mile north of Guthrie, the Dolese Co. dredges sand from the Cimarron River 0.5 mile east of the Cimarron River bridge (map location 9). 9

Two miles east of U.S. 77 on Bypass 142 around Ardmore is the Vickers Petroleum Corp. refinery. The refinery will have refining capacity of 60,000 barrels of oil per day by 1976 after completion of a new addition (map location 79). 79

U.S. 81.—In Garfield County, in the northeast part of Enid east of U.S. 81, is the Champlin Petroleum Co. refinery. The refinery is capable of refining 48,000 barrels of crude oil per day (map location 70). 70

In Kingfisher County, the Dolese Co. dredges sand from alluvium in the Cimarron River west of the Cimarron River bridge (map location 8). 8

In Canadian County, 3 miles north of Union City and west on U.S. 81, shale is dug from the Dog Creek Shale of Permian age by the Acme Brick Co. (map location 1). The shale is sent to the Clinton plant for the manufacture of brick (map location 3). 1 3

The Oklahoma Brick Corp. operates fully automated plants for making clay and cement brick 2.5 miles north of Union City, west of U.S. 81 (map location 36). 36

Basic material used in the clay brick is obtained locally from the Dog Creek Shale of Permian age. Products are shipped widely throughout the North-Central and South-Central States.

In Stephens County, 7 miles south of Duncan in the northeastern part of Beckett (Sunray Village), is a Sun Oil Co. refinery with a capacity for refining 48,500 barrels of crude oil per day (map location 75).

75

U.S. 169.—Several long-abandoned strip pits are present on both sides of U.S. 169 a mile south of Collinsville in Tulsa County. Some pits close to the highway have been filled and leveled and are used for commercial and industrial purposes.

South of Owasso, terrain east of the highway is dominated by a westward dipping slope on the Oologah Limestone of Pennsylvanian age. The limestone has numerous constructional uses and chemical qualities that are suitable for agricultural limestone and for preparing cement. Numerous quarries fill a large part of the needs for limestone in Tulsa County and adjacent parts of neighboring counties.

29

One mile east of U.S. 169 on Okla. 266 is the quarry of Anchor Stone Co. (map location 29). One mile south of Okla. 266, east of U.S. 169, are the quarry, crushing plant, and hot mix plant of Standard Industries, Inc. (map location 31). Two miles south of Okla. 266, east of U.S. 169, Martin Marietta Cement Co. operates a fully automated cement plant (map location 41). Limestone is obtained from an adjacent quarry. Environmental controls prevent the escape of any appreciable airborne or waterborne pollutants from the Martin Marietta plant.

31

41

Chat piles on U.S. 69 in the vicinity of Picher and Cardin, Ottawa County, Okla., in the Tri-State lead-zinc district. (Courtesy of Oklahoma Geological Survey.)

U.S. 270.—Between Dow and Bache, north of U.S. 270, coal is strip mined for Lone Star Steel Co. (map location 50). In this same area, old unreclaimed strip mines also parallel the highway. 50

Three miles west of Wewoka and a mile north of U.S 270, gray and dark blue shale of Pennsylvanian age is mined by Commercial Brick Corp. for making brick in the plant at Wewoka (map location 42). The plant is fully automated and uses a unique European grinding method for preparing the raw material. Brick made at the plant is distributed primarily in Oklahoma. Visitors are welcome at the plant; for additional information, see the section 'Mines and Plants You Can Visit." 42

Clay and shale similar to that used bv Commercial Brick Corp. is mined by United Clay Pipe Co. at its plant west of Wewoka and 2 miles north of U.S. 270 (map location 34). Raw materials are processed and manufactured into clay pipe, pottery, and flowerpots at the plant, which is 3 miles southeast of Seminole and adjacent to U.S. 270. The pipe has a regional market from Colorado to Louisiana and from New Mexico to Missouri. The pottery produced by the company is distributed nationally. Visitors are welcome at the plant. 34

U.S. 277.—South of U.S. 277 at Cyril, Apco Oil Corp. refines crude oil. Refinery capacity is 12,000 barrels of crude oil per day (map location 69). 69

In Comanche County, 1 mile north of Fletcher and east of U.S. 277, gypsum is mined by the Temple Gypsum Div. of Temple-Eastex Inc. (map location 58). The gypsum is shipped to Irving, Tex., and West Memphis, Ark., for manufacturing wallboard. The gypsum beds are in the Cloud Chief Formation of Permian age. 58

U.S. 283.—In Greer County, 6 miles east on Okla. 9 and north of U.S. 283 on the west side of Granite, Fairfax Granite Co. quarries red granite as monument stone that is distributed through Rock of Ages, Barre, Vt. (map location 43). Willis Granite Co. and monument works are situated on the north edge of the city of Granite. 43

The present plant of Mangum Brick Co. is located 0.5 mile southwest of Mangum on Okla. 34, on the west side of U.S. 283 (map location 35). The plant, built in 1965, is the successor to the original plant of Mangum Pressed Brick Co., which originated in 1909. Flowerpot Shale of Permian age is the source of clay for brick that is distributed within a radius of 200 miles. 35

In Jackson County, 9 miles west of Elmer on Okla. 5, an 8-inch zone in the Flowerpot Shale of Permian age contains sufficient copper sulfides and oxides with some silver to have been strip mined between

46 1965 and 1975 (map location 46). Eagle-Picher Industries, Inc., mined and milled ore to produce copper concentrates for smelting. Most strip mined areas have been leveled in compliance with State law.

Okla. 1, Okla. 12.—The highway traverses the Arbuckle Mountains of Oklahoma at their widest point. Sedimentary rock formations exposed from about 3.5 miles northeast of Fitzhugh in Pontotoc County to Mill Creek in Johnston County are limestone and high-purity silica sands, mostly of Ordovician age, folded, and complexly faulted. For a distance of 3 miles south of Mill Creek, the surface rocks exposed in multiple fault blocks are mostly of Pennsylvanian age. From there south almost to Ravia, granite of Precambrian age is the surface rock. Limestone, dolomite, sandstone, and granite are quarried at one or more of seven quarry operations near the highway.

89 In Pontotoc County, in the southwest part of Ada, east of Okla. 1, can be seen the Ada plant of the Ideal Cement Co. (map location 89). Two miles northeast of Fitzhugh, east of Okla. 1, is the quarry of the 40 Ideal Cement Co. (map location 40). The relatively pure high-calcium Fernvale Limestone has been quarried since 1907.

Two miles northeast of Roff, west of Okla. 1, the Midcontinent Glass Sand Co. mines sand for making 15 glass from the McLish Sand of Ordovician age (map location 15). The sand is so poorly consolidated that it is disaggregated in the pit by hydraulic pressure. Although most of the product is sold in Oklahoma, some is distributed as far as the Atlantic and Pacific coasts.

In Johnston County, Pennsylvania Glass Sand Corp. mines sand for making glass from the Oil Creek Sand of Ordovician age at an old plant 1 mile north of Mill 16 Creek, east of the highway (map location 16), and at a new plant 2 miles south of the junction of Okla. 12 and Okla. 7, west of the highway (map location 17). 17 Oil Creek Sand is similar to the McLish Sand and is mined and transported to the plant by a hydraulic system. Markets are nationwide and foreign.

Three miles south of Mill Creek on both sides of the highway are inactive granite quarries of Century 45 Granite Co., Inc. (map location 45). In 1975, the active quarry area was about three-quarters of a mile to the east.

Three miles south of Mill Creek, west of the highway, the Boadie Anderson Quarries are set back from 44 the highway about one-half mile (map location 44). The derrick and boom for the granite quarries are visible from the highway close to Delta Mining Co.

One mile north of Troy, west of the highway, is the Delta Mining Co. mill for crushing and preparing

dolomite (map location 57). The high-magnesium dolomite is used in glass manufacture and as asphalt filler. The rock is quarried from the Royer Dolomite of Cambro-Ordovician age 3 miles west of the plant. 57

Okla. 2.—Booms of the draglines used by Carbonex Coal Co. to mine Stigler coal are visible east of Okla. 2 about 2 miles north of Porum (map location 47). The coal is used in electric generation and as fuel for cement plants. 47

Okla. 8.—Universal Atlas Cement Div. of United States Steel Corp. strip mines gypsum 6 miles northeast of Watonga in Blaine County (map location 27) for use in making cement. Gypsum is obtained from the Blaine Gypsum of Permian age. The entire product is shipped by rail to affiliated and unaffiliated cement plants in other States for use as cement retarder. 27

Okla. 9.—Mining activities are visible in the eastern segment of Okla. 9 from the State line to Eufaula in McIntosh County. Unreclaimed orphan coal strip mines are visible at intervals mostly north of the highway in the western part of Sequoyah County. Similar orphan strip mines are visible as far west as Whitefield in Haskell County. Those between Stigler and Whitefield have been partly reclaimed by smoothing tops of the piles and reestablishing grass.

Garland Coal & Mining Co. mine located near Okla. 9 northeast of Stigler in Haskell County. As much as 95 feet of overburden is stripped to mine 16 to 22 inches of Stigler Coal. This metallurgical coal is shipped to Germany. The dragline bucket has a 30-yard capacity.

87 Three miles west of Keota, south of Okla. 9, Garland Coal & Mining Co. built a station at the Port of Keota to load coal on barges (map location 87). The coal is shipped via the McClellan-Kerr Arkansas River Navigation System to New Orleans, where it is transhipped to Germany for metallurgical purposes. The loader will deliver 600 tons of coal per hour to two barges moored alongside. Channel characteristics of the waterway limit the maximum barge draft to 8 feet and maximum load to 1,300 tons of coal.

20 A seam of Stigler Coal 18 to 22 inches thick is mined by Garland Coal & Mining Co. 1 mile east and 1 mile north of Stigler (map location 20). Because the coal is convertible to coke for metallurgical purposes, it has a relatively high value, allowing the company to strip as much as 95 feet of overlying shale and sandstone in order to mine the coal seam. The company reclaims mined land generally for agricultural and grazing purposes.

19 **Okla. 10.**—Four miles west of Welch, north of Okla. 10, Bill's Coal Co., Inc., mines the Sequoyah Coal by strip methods (map location 19). Most of the coal is shipped to Missouri for generating electricity.

66 Limestone of the Fort Scott Formation is quarried 1.5 miles west of Hollow, south of Okla. 10, for concrete aggregate and agricultural lime by O'Brien Rock Co., Inc. (map location 66). The operators crush the rock with portable equipment.

Okla. 16.—Ten miles east of U.S. 75, south of Okla. 16 in Okmulgee County, limestone of the Sonora For-

mation is quarried by George Cummins Construction Co. (map location 53).

Okla. 20.—Three miles east of Pryor (Pryor Creek), upper parts of the Oklahoma Cement Co. plant are visible from the highway (map location 63). Associated quarries to provide limestone for preparing cement are in the Hindsville Formation of Mississippian age.

One mile west of Hominy, north of Okla. 20 in Osage County, Leco Materials, Inc., quarries LeCompton Limestone of Pennsylvanian age for concrete aggregate (map location 54).

Okla. 22.—Five miles west of Kenefic, north of Okla. 22, Bryan County Limestone Co. quarries Goodland Limestone of Cretaceous age (map location 52). The limestone is crushed in stationary equipment at the quarry and is used for road base, concrete and asphalt aggregate, and agricultural lime in southern Oklahoma and northern Texas.

Okla. 30.—Salt brines from the Flowerpot Shale of Permian age are pumped from wells and evaporated by solar heat by Acme Salt Co. 21 miles north of Hollis and 0.75 mile west of Okla. 30 on Elm Fork in Harmon County (map location 88). The salt is used as stock feed and water softener recharger.

Okla. 31.—A coal strip mine of Garland Coal & Mining Co. is located 1.5 miles south of Okla. 31 at Bokoshe (map location 21). Some unreclaimed orphan coal strip pits are visible at Bokoshe. A coal strip mine was established in late 1974 by Paul Rees Coal Co. one-fourth mile south of Okla. 31 near Milton in LeFlore County (map location 48).

In Haskell County 4 miles north of McCurtain on Okla. 26 can be seen recently mined and reclaimed land of the Lone Star Steel Co. Starlight mine (map location 49). The Stigler Coal was used for metallurgical purposes. The Lone Star Steel Co. piloted volunteer return of topsoil to leveled spoil pines and thus was able to reestablish a grass-covered surface almost indistinguishable from the original surface. Mined land 1 mile north of McCurtain has been partly reclaimed by rounding tops of spoil piles, and reclaimed strip pits on the west side of McCurtain have been converted to a city recreational area.

Other signs of earlier mining activity along Okla. 31 appear in Haskell and Pittsburg Counties. Strip pits in the vicinity of Kinta in Haskell County are mostly unreclaimed. A few small unreclaimed coal strip pits are visible near Blocker and east of Krebs in Pittsburg County. The general vicinity of McAlester was the site of numerous underground coal mines as late as 1963, after which underground mining ceased.

Okla. 33.—In Payne County, Midland Cooperatives, Inc., petroleum refinery on the west side of Cushing

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73 has the capacity to process 17,740 barrels of crude oil per day (map location 73).

Okla. 51.—In Blaine County 2 miles northeast of Southard and south of Okla. 51, Walton Gypsum Co.
28 strip mines gypsum and prepares it for use as cement retarder and agricultural gypsum (map location 28). Blaine Gypsum of Permian age is the source bed.

At Southard southeast of Okla. 51 and 2.5 miles north of Southard on Okla. 51A, Blaine Gypsum is strip mined by United States Gypsum Co. (map loca-
26 tion 26). The products are crude and calcined gypsum. The company's efforts to reclaim some of its pits include filling and regrassing, as displayed east of the plant, creating small lakes and stocking them for fishing, and planting vegetation that will produce habitat for game birds and deer in the rough areas.

In Ellis County, 1 mile west of Harmon and south of Okla. 51, Tonkawa Refining Co. operates a plant that
78 can refine 5,000 barrels of crude oil per day (map location 78).

Okla. 99.—Superior Clay Products, Inc., manufactures brick in southeast Ada from clay and shale of
38 the Ada Formation of Pennsylvanian age (map location 38). The brick is sold in south-central Oklahoma.

Four miles south of Fittstown, east of Okla. 99, limestone of Ordovician age is quarried by C & O

Materials, Inc., for cement and bituminous aggregate and for dense road base (map location 64). The rock is crushed and prepared in a stationary plant at the quarry site. 64

Okla. 152.—Although largely devoid of mining activity, Okla. 152 crosses diagonally over the subsurface Anadarko Basin. Drilling rigs and surface installations for collecting natural gas and crude oil from wells are evidence of subsurface resources. In 1975, deep drilling concentrated on the search for natural gas resources considered to be potentially among the greatest in the Nation.

In Washita County 11 miles west of Cordell and 1 mile north of Okla. 152, Lone Star Producing Co.'s No. 1 Bertha Rogers, the deepest hole in the world, was drilled to a depth of 31,441 feet in 1974 (map location 83). Flow of liquid sulfur from a deep bed filled the hole back to about 14,000 feet and prevented testing for natural gas in deep strata. Gas production from beds deeper than 25,000 feet has been established elsewhere in the Anadarko Basin. 83

H. E. Bailey Turnpike.—Ten miles southwest of the Chickasha tollgate, Harrison Gypsum Co. strip mines gypsum in the Cloud Chief Formation of Permian age (map location 51). The products are sold for cement retarder and agricultural gypsum. 51

Quarry and plant of Martin Marrietta Cement Co. on U.S. 169 east of Tulsa, Rogers County. The plant is essentially fully automated and has a complete environmental protection system.

MINES AND PLANTS YOU CAN VISIT

Active mines and mineral processing plants and abandoned operations hide many hazards for the worker and especially for the casual visitor. Health and safety conditions in mines and some plants are under the control of the Federal Mining Enforcement and Safety Administration (MESA). Other plants are regulated by the Occupational Safety and Health Administration (OSHA). Because of the regulations enforced by MESA and OSHA, many firms have hard and fast rules prohibiting visitors. Others tolerate visitors who have received entry permission from management, and a few invite "drop in" visitors. Companies that have expressed willingness to receive visitors are identified along with the proper contact for obtaining permission to visit. Travelers are cautioned that both abandoned mine sites and mineral activities can be visited safely only when permission to visit has been granted and a qualified guide is provided.

U.S. 56.—North of U.S. 56 in Cimarron County, 4.5 miles northeast of Keyes, is the Federal Bureau of Mines Helium Operation, one of three plants operated by the Bureau to extract and refine helium for natural gas for commercial and scientific use (map location 67). Nominal production capacity of the plant is 420 million cubic feet per year. Refined helium is at least 99.995 percent pure. Some of the applications of helium are in arc welding, ballooning and lighter-than-air activities, heat transfer in nuclear reactors, space technology, undersea artificial atmospheres, and cryogenics. Visitors are welcome. For permission to tour the plant, contact the general manager, Federal Bureau of Mines Helium Operation, P.O. Box H, 4372 Herring Plaza, Amarillo, Tex. 79106, or call (806) 376-2602.

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U.S. 66.—Frankoma Pottery, Inc., extracts clay and shale from the Coffeyville Formation of Pennsylvanian age in pits south of U.S. 66 in the southwestern part of Salpulpa (map location 86). Frankoma Pottery, Inc., manufactures pottery, including dinnerware, florist items, and artware. Visitors are welcome to tour Frankoma's plant and showrooms at the pottery in downtown Sapulpa. Arrangements for touring the plant can be made by writing to J. W. Daugherty, at P.O. Box 789, Sapulpa, Okla. 74066 or calling (918) 224-5511.

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In Custer County 1 mile west of the U.S. 183 underpass on U.S. 66, the Acme Brick Co. makes brick from clay of the Cloud Chief Formation of Permian age (map location 3). Uniquely pink or beige brick are marketed through Acme's nationwide system. Visitors are welcome. For permission to tour the plant, contact T. W. Poyner, P.O. Box 24010, Oklahoma City,

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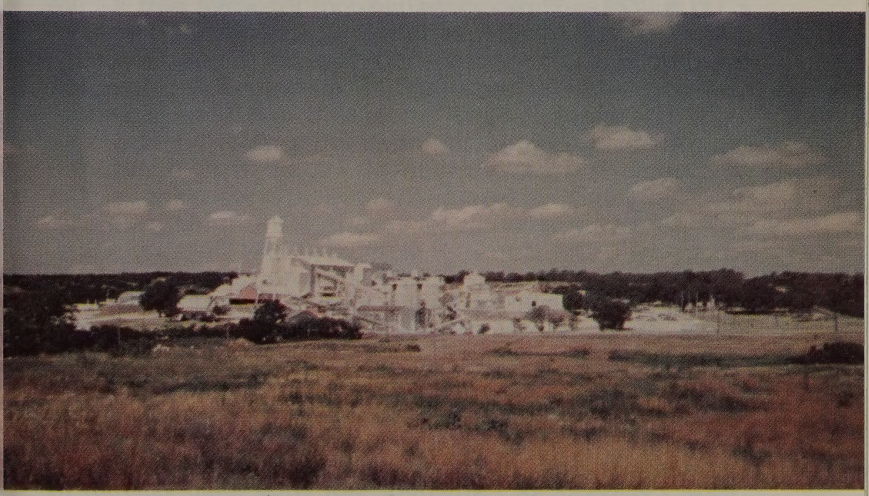
Okla. 73124 or call (405) 525-6657.

U.S. 69.—On U.S. 69, 1 mile north of the junction with U.S. 66, the VanPoole mine, formerly an active zinc mine, is operated as a commercial attraction during the tourist season (map location 84). Visitors may take an underground tour for a modest fee. Inquiries should be addressed to O. K. Tucker, 540 East 13th Street, Baxter Springs, Kans. 66713 or call (316) 856-5890. 84

U.S. 77.—The Acme brick plant southwest of Edmond in Oklahoma County (map location 2) has an annual capacity of 20 million building bricks. The plant is situated 5 miles north of U.S. 66 on the west side of Broadway Extension (U.S. 77). Face brick is made from local clays mined at the plant site. Automation is applied through the process of preparing green brick. Permission to visit the plant may be obtained from the plant manager by writing to P.O. Box 14566, Oklahoma City, Okla. 73114 or calling (405) 751-2516. 2

Tulsa City Site.—Acme Brick Co. mines shale and manufactures face brick at a plant in Tulsa (map location 4). To reach the plant, exit from Interstate 244 (Crosstown Expressway) onto Yale Avenue and proceed north 1.5 miles to Dawson Road. The plant is on the north side of Dawson Road, west of the intersection. Partial automation supports a plant capacity of more than 40 million bricks per year. Requests to tour the plant may be made to the personnel and safety officer, P.O. Box 51193, Tulsa, Okla. 4



United States Gypsum Co. plant at Southard in Blaine County. Grass cover in the foreground back to the line of trees and the plant was established on a filled and reclaimed strip pit.

Temple mine of the Temple Gypsum Div., Temple-Eastex Inc., on U.S. 277 near Fletcher, Comanche County. The mine is a source of crude gypsum. (Courtesy of Oklahoma Geological Survey.)

74151 or call (918) 932-3384.

U.S. 270.—Three miles west of Wewoka and a mile north of U.S. 270, gray and blue shale of Pennsylvanian age is mined by Commercial Brick Corp. for making brick in the plant at Wewoka (map location 42). The plant is fully automated and uses a unique European grinding method for preparing the raw material. The brick made at the plant is distributed primarily in Oklahoma. Visitors are welcome at the plant. Arrangements for touring the plant may be made with Bill Harris, P.O. Box 15158, Del City, Okla. 73115 or call (405) 272-0721.

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Clay and shale similar to that used by Commercial Brick Corp. is mined by United Clay Pipe at its pit 3 miles west of Wewoka and 2 miles north of U.S. 270 (map location 34). Raw materials are processed and manufactured into clay pipe, pottery, and flowerpots at the plant, which is 3 miles southeast of Seminole adjacent to U.S. 270. The pipe has a regional market from Colorado to Louisiana and from New Mexico to Missouri. Pottery from the plant is distributed nationally. Visitors are welcome at the plant. To make arrangements for touring the plant, write to Jack Sullivan, P.O. Box 552, Seminole, Okla. 74868 or telephone (405) 382-0212.

34

HISTORICAL SITE

U.S. 60.—On Okla. 123 north of U.S. 60, in Johnstone Park, Bartlesville, Cudahy Oil Co. completed the No. 1 Nellie Johnstone oil well, producing 30 barrels of oil per day, in April 1897 (map location 80). This was the first commercially produced oil well in Oklahoma. A replica of the old well marks the site of the discovery. Other noteworthy petroleum installations in Bartlesville include the home office of Phillips Petroleum Co. in the downtown area and the Bartlesville Energy Research Center of the Energy Research and Development Administration. The research center is on Virginia Street in the northwestern part of the city.

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FOR MORE INFORMATION WRITE OR VISIT

Federal Bureau of Mines Liaison Office, 168 Post Office Building, N.W. Third Street, Oklahoma City, Okla. 73102.

Oklahoma Department of Mines, 117 State Capitol, Oklahoma City, Okla. 73105.

Oklahoma Geological Survey, 830 Van Vleet Oval, Norman, Okla. 73069.

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Geological Map of Oklahoma, by H. D. Miser. U.S. Geological Survey and Oklahoma Geological Survey, 1954.

Maps and Descriptions of Disturbed and Reclaimed Surface-Mined Coal Lands in Eastern Oklahoma, by K. S. Johnson. Oklahoma Geological Survey in cooperation with the Oklahoma Department of Mines, Map GM-17, 1974, 12 pp., 3 maps.

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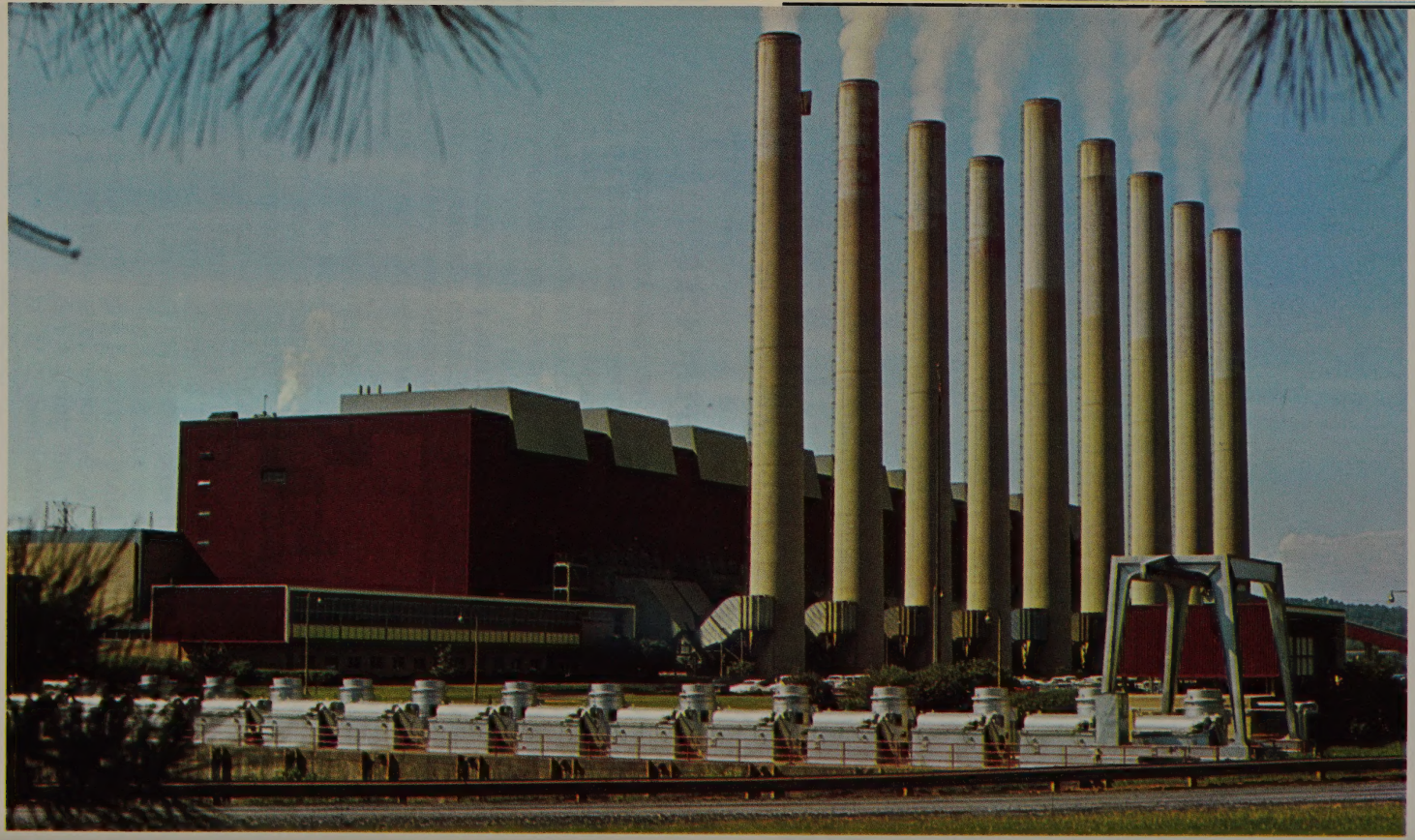


Tennessee Valley Authority coal-fired steam powerplant at Kingston, Tenn.

TENNESSEE

by
William D. Hardeman

Tennessee has a long history of mining and a variety of mineral deposits and mineral industries. It is the leading State in the production of zinc ore and concentrates, a major producer and processor of phosphate ore, an important coal producing State, the Nation's leading producer of ball clays, and has the only large copper mines and smelter in the Southeast.

MINES AND PLANTS YOU CAN SEE FROM THE HIGHWAYS

BALL CLAYS

Tennessee is the Nation's leading producer of ball clay—a very plastic high-grade ceramic clay that is widely used in the manufacture of pottery, whiteware high-grade tile, refractories, and various other ceramic products. In the production of ball clays for special uses, it is necessary to use clays of slightly different character from different pits. Often clays from different pits are blended to obtain the desired product. Therefore, a clay pit that may appear to be inactive is actually being operated from time to time as required. There are numerous clay pits in Henry and Weakley Counties, and the plants of the major companies operating in the area may be seen along the following highways.

U.S. 79.—The H. C. Spinks Clay Co. plant is located about 1 mile northwest of U.S. 79 on a county road that intersects the highway about 2½ miles northeast of the town of Henry in Henry County (map location 1). 1

Tenn. 22.—Three plants may be seen on the east side of the highway between 2 and 3 miles northwest of Gleason in Weakley County (map location 2). From south to north these are the United Sierra Div. of Cypress Mines Corp. plant, Old Hickory Clay Co. plant, and Kentucky-Tennessee Co. plant. 2

COMMON CLAY

Clay and shale deposits suitable for the production

of construction products (brick, tile, pipe, etc.) are mined and processed in locations near population centers throughout the State. Some of these operations are located as follows:

Tenn. 12—Nashville.—The W. G. Bush Co. plant is located on Old Hickory Boulevard just south of its intersection with the highway at Scottsboro, which is about 5 miles west of the city.

Interstate 640—Knoxville.—The General Shale Products Corp. mine and plant may be seen at the intersection of the interstate and Broadway.

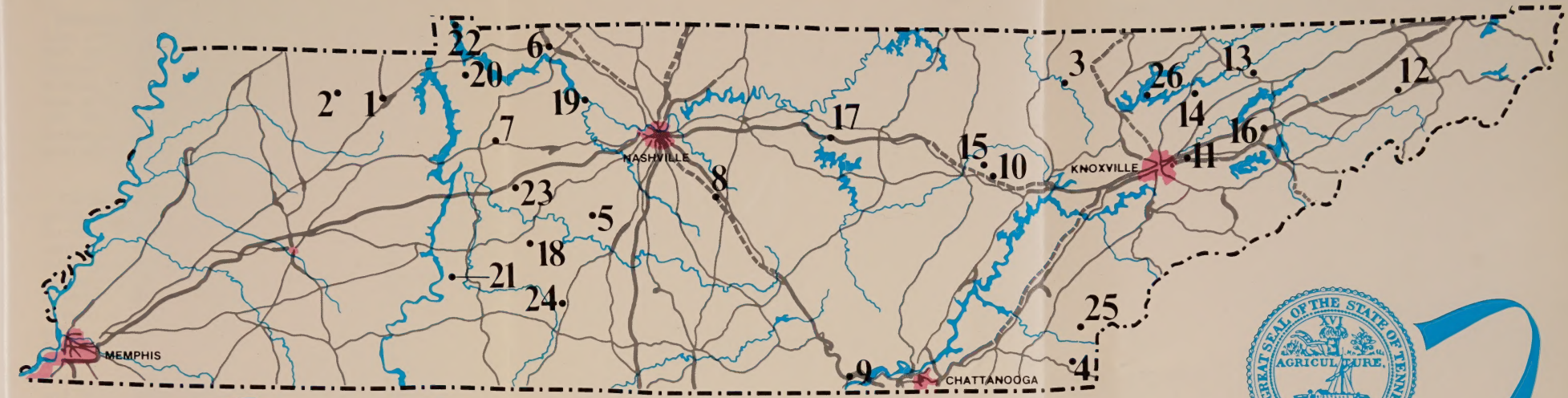
Tenn. 67—Johnson City.—Another plant of General Shale may be seen on the north side of the highway within the city limits.

COAL

Tennessee produces about 9 million tons of coal per year from about 120 mines, more than 60 percent of which are strip mines. The mines are scattered

Surface coal mining in Campbell County, Tenn. (Courtesy of Tennessee Department of Conservation.)

throughout 13 counties of the Cumberland Plateau region but are mostly concentrated in Anderson, Campbell, Claiborne and Scott Counties. Most of the coal is sold to the Tennessee Valley Authority (TVA) to produce electricity in their coal-fired steam plants in the Valley area. Most of the surface mining is done by contour stripping of the overburden over the coal on relatively steep slopes. This type of mining in Tennessee has been subject to much criticism by numerous environmental groups. The new Tennessee Surface Mine Law became effective in 1972, and strict administration of this law should result in the satisfactory reclamation of areas mined since that time. Mining done prior to 1972 in general has not been adequately reclaimed and probably will not be until time and nature have healed the scars. The best route



LEGEND

1— Clay processing plant
2— Clay processing plants
3— Strip coal mining area
4— Copper mining district
5— Phosphate rock mining and processing district
6— Limestone quarry
7— Limestone quarry
8— Limestone quarry
9— Underground limestone quarry
10— Limestone quarry
11— Limestone quarry
12— Limestone quarry
13— Marble quarry
14— Marble quarry
15— Sandstone quarrying district
16— Mascot—Jefferson City zinc district
17— Zinc mines
18— Old Aetna Furnace ruins
19— Cumberland Furnace ruins
20— Bear Spring Furnace ruins
21— Cedar Grove Iron Works ruins
22— Great Western Furnace ruins
23— Lee Furnace ruins
24— Historic Napier Iron Mine
25— Coker Creek gold mining district (inactive)
26— Lead Mine Bend mining district (inactive)

0 40 80 MILES

to observe the results of coal strip mining is Interstate 75.

Interstate 75.—From Lake City to Jellico on both sides of the Interstate Highway many coal strip mines, both active and abandoned, may be seen as large contour cuts along the sides of the mountains (map location 3). This highway furnishes an outstanding view of the results of coal strip mining in rugged terrain. Most of this mining was done before the new reclamation law was passed and, therefore, has not been satisfactorily reclaimed.

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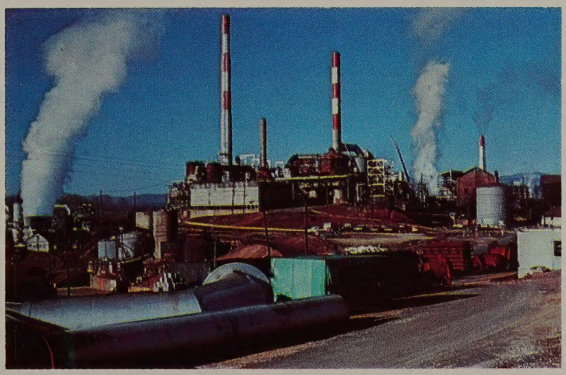
COPPER

Tennessee is the only State in the Southeast in which copper is mined. Copper production in the Ducktown mining district began about 1850 and has continued since that date. The uncontrolled release of sulfur gases from early smelter operations completely denuded an area of about 7,000 acres of all types of vegetation. However, in 1907, the former owner, Tennessee Copper Co., began to remove most of the sulfur gases and to convert them to an important commercial product—sulfuric acid, and the damage from sulfur gases was eliminated. Now even more of these gases must be removed under the strict State and Federal air pollution control regulations. Cities Service Co. is the only operator in the area. At present, four large underground mines are in operation that supply ore at the rate of about 7,000 tons per day to a complex of processing plants and smelting operations. The primary products of the company are 21,000 tons per year of copper metal, 26,000 tons per year of zinc concentrates, 917,000 tons per year of iron pellets, and 1,315,000 tons of sulfuric acid. Minor amounts of gold and silver are recovered when the copper metal is further refined. The mines and plants may be observed from the following highways:



Copperhill operations of the Cities Service Co. (Courtesy of Tennessee Department of Conservation.)

Vulcan Materials Kingsport quarry. (Courtesy of Vulcan Materials, Inc.)

This is an underground quarry, mining a thickness of 60 feet of high-calcium limestone for the chemical industry.

U.S. 70.—Ideal Cement's quarry is in Knoxville just west of the Holston River and north of the highway
11 near the Interstate 40 interchange (map location 11). This is also an open-face quarry with a 60-foot face.

U.S. 11W.—Vulcan Materials Kingsport plant 525
12 just west of Kingsport in Johnson County about one-half mile north of highway (map location 12). This is an open-face quarry with a 200-foot face.

MARBLE

Tennessee has long been a leading producer of marble. Marble from early quarries in eastern Tennessee has been used in many famous buildings throughout the country. About one-half of the ornamental marble used in the Capitol Building in Washington, D.C., came from the "Old Daugherty" quarry just south of U.S. 11W near Galbraith Springs. The present quarry industry in the Knoxville area dates from 1852. There are four active quarries and two fabrication plants that produce stone with a wide variety of very attractive colors. The highways from which the marble quarries are visible are as follows:

U.S. 25.—The Imperial Black Marble Co. quarry in
13 Grainger County about 2 miles north of Thorn Hill on the east side of the highway (map location 13).

Tenn. 61.—The Luttrell quarry of the Tennessee Div. of the Georgia Marble Co. in Union County just
14 north of the town of Luttrell on the east side of the highway (map location 14).

There are two major fabrication plants located in

Knoxville: The Eagle Mill of the Tennessee Marble Div. (on Riverside Drive about 1 mile east of the U.S. 441 bridge over the Tennessee River) and the Candoro Marble Co. plant (on Maryville Pike about 2 miles south of this same bridge).

SANDSTONE

Tennessee also produces an unusually attractive type of dimension sandstone, Crab Orchard Sandstone, which is shipped throughout the Nation.

U.S. 70.—The center of this quarrying activity is just east of Crossville on U.S. 70N. Several plants can be seen along the highway (map location 15). **15**

ZINC

Tennessee has the largest zinc ore mining industry in the United States. Three companies operate six large mines in the Mascot-Jefferson City mining district of eastern Tennessee. A large new mine is being opened in middle Tennessee near Carthage. Tennessee has very large reserves of zinc ore, and large-scale mining will probably continue indefinitely. Some of the mines and plants are located along the following highways:

U.S. 11E.—The Mascot-Jefferson City zinc district can be viewed along this highway between Knoxville and Jefferson City (map location 16). Headframes of the mines and the concentrating mills can be seen along the route. About 13 miles east of Knoxville, the Asarco mill located in Mascot may be seen at a distance on the left; 2 miles further east is the headframe of the Immel mine. Still further east, 4 to 5 miles, a **16**

Drilling in the breccia ore of the New Jersey Zinc Co. Jefferson City mine.

Loading surface mined coal. (Courtesy of Tennessee Department of Conservation.)

sign on the right indicates Asarco's Young mine, which is a short distance from the highway. At the Friend's Station crossroad, the road to the south leads to Asarco's New Market mine. On the eastern edge of Jefferson City the Coy mine of Asarco is located just off the highway.

Tenn. 92.—The Jefferson City mine and concentrating mill of the New Jersey Zinc Co. may be seen just to the left of the highway, 1¼ miles south of its intersection with U.S. 11E in Jefferson City. The U.S. Steel Davis mine and concentrating mill is located on the opposite side of the highway about one-half mile south of this same intersection but is further from the highway and more difficult to see.

U.S. 70N.—About 3 miles east of the bridge leading to Carthage in Smith County, and just as the bridge over the Caney Fork River is approached, the new Elmwood mine of the New Jersey Zinc. Co. may be seen about 1 mile south and up the valley of the river (map location 17).

17

MINES AND PLANTS YOU CAN VISIT

None of the mining companies operating in Tennessee have an established policy for visitors. There are no scheduled tours at the mines; in general, the companies discourage visits by the general public. In some special instances, a company might allow visiting, but only after arrangements have been made with and permission granted by the management.

GHOST TOWNS AND HISTORICAL SITES

Tenn. 48.—The ruins of the Aetna Furnace, a hot blast charcoal furnace, may be seen next to Tenn. 48 in the village of Aetna, about 3½ miles south of the intersection of this highway and Tenn. 100 (map location 18). This stack was built in 1883 and operated until 1891 with a daily capacity of 45 tons of pig iron. The old Aetna Furnace was located some 3 miles to the north on the bank of Beaverdam Creek and was built in 1836 but was destroyed by the Union Army in 1862. **18**

The foundation of the old Cumberland Furnace may be seen just north of the village of Cumberland Furnace on Tenn. 48 (map location 19). On the opposite side of the road are two large weatherbeaten buildings—the old railroad station and the old company commissary. James Robertson, the Father of Middle Tennessee, started the first furnace operation here in 1797, a charcoal cold-blast furnace. It was rebuilt in 1825 and in 1854 was operating as a charcoal-feed, steam-power, hot-blast furnace. Records are unclear, but the furnace operated, at least intermittently, until 1930 when active operations ceased, although the furnace was put into blast for a short period in 1937. Thus, there were furnace operations here over a period of 140 years. **19**

Bear Springs iron furnace near Dover, Tenn.

Tenn. 49.—The stack of the Bear Spring Furnace may be seen adjacent to Tenn. 49 at Bear Springs, about 5 miles southeast of Dover in Stewart County (map location 20). It is 36 feet square at the base and about 50 feet in height. Joseph and Robert Woods and Thomas Yeatman built a charcoal cold-blast furnace here in 1830. It used brown iron ore from local deposits but was destroyed by Union forces in 1862. The present stack was built in 1873; operations were discontinued in 1901. There is a Tennessee historical marker at the site. The last cold-blast charcoal furnace to operate in the United States was the Dover No. 2, which operated until 1927 at Cargile about 4 miles south on Tenn. 49, but only piles of rubble now mark the site.

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Tenn. 20 and 100.—The ruins of the old Cedar Grove Iron Works may be seen adjacent to a secondary road about 1½ miles northeast of Cedar Creek Landing commercial boat dock and 7½ miles south of the road's intersection with Tenn. 20 and 100 (map location 21). There is a Tennessee historical marker at this intersection, which is 5½ miles west of Linden in Perry County. This old furnace was built in 1834 and used ore from nearby deposits. Operations were discontinued in 1862. The ruins consist of a stack 30 feet square at the bottom and about 45 feet high.

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Tenn. 49.—The well-preserved ruins of the Great Western Furnace, 36 feet square at the base and 40 feet high, may be seen adjacent to the highway within the Land-Between-the-Lakes Recreation Area about 11 miles north of its southern boundary (map location 22). This was a steam-powered, cold-blast charcoal

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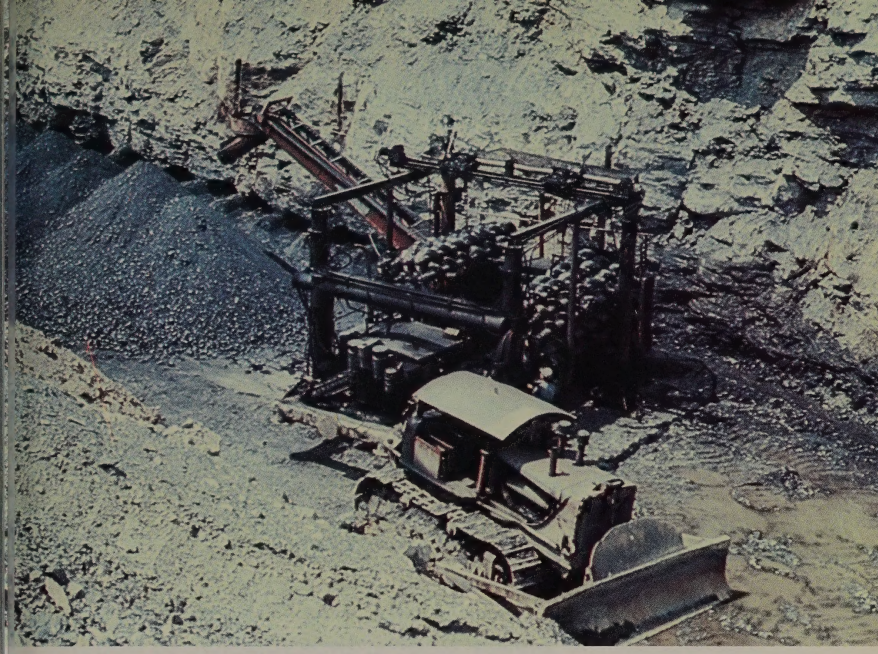
Danley quarry near Nashville, Tenn. (Courtesy of Vulcan Materials, Inc.)



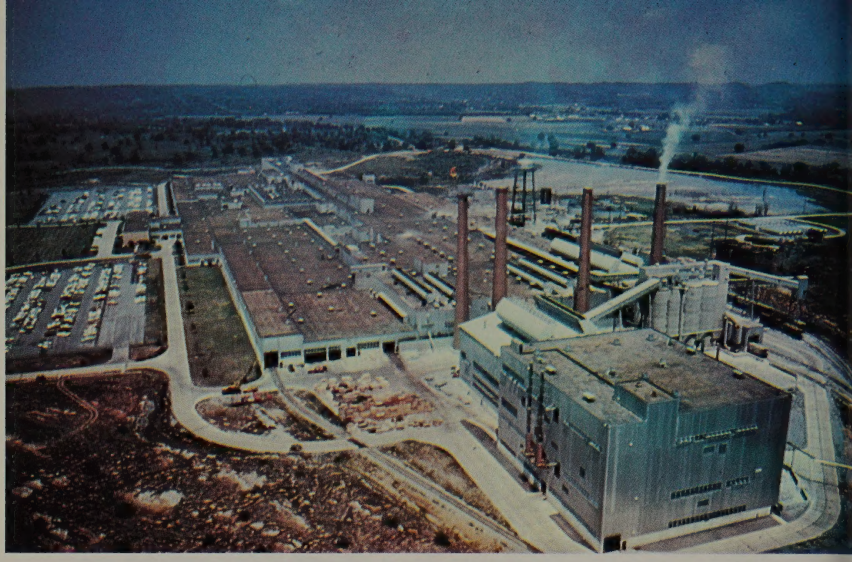
Auger mining in the Cumberland Mountains. (Courtesy of Tennessee Department of Conservation.)

furnace built in 1856 by Brian, Newell and Co. from local limestone deposits. The pig iron was shipped by river or hauled to rolling mills in the east. It closed in 1854 due to lack of ore and a slave insurrection by the furnace crew.

Interstate 40.—The ruins of the old Lee Furnace, a stone stack about 30 feet square at the base and 25 feet high, may be seen on the east side of the road and about one-fourth mile south of the Bucksnort Exit of Interstate 40 in Hickman County (map location 23). This furnace operated as early as 1821, and the pig iron was hauled to Duck River where it was carried on flatboats to markets. There is no record of when operations ceased. 23

Natchez Trace Parkway.—The old Napier Iron Mine, a National Park Service historical site, may be seen adjacent to the Parkway in Lewis County about 1½ miles south of the bridge over Buffalo River (map location 24). The old opencuts may be observed from an overlook. A shelter contains a pictorial history of the old operations and exhibits of the iron ore and products manufactured from the pig iron produced by the local furnaces. 24

Tenn. 68.—The old Coker Creek gold mining district was discovered in 1827, and by 1831, hundreds of men were panning gold from the sands and gravels of the creek although the land at that time still belonged to the Cherokee Indians. Mining on a substantial scale began in 1856. The Cooper mine was one of the best known of the Coker Creek workings and is



Ford Co. glass plant at Nashville, Tenn., where glass is produced from glass sand mined near Camden, Tenn. (Courtesy of Mineral Resource Section, Tennessee Valley Authority.)

located on the east side of the intersection of the road to Dalton Branch with the old Madisonville-Murphy Pike about one-half mile southeast of Tenn. 68 (map location 25). The old mine consisted of a one-half acre tract, which produced $80,000 worth of gold, most of which was mined in the 1870's. The gold included many nuggets, two of which weighed 1¼ pounds valued at that time at $360 each. Mining ceased in this area in the early 1880's.

25

Tenn. 33.—The New Prospect lead mine was the most important mine of the old Lead Mine Bend mining district in Union County (map location 26). This abandoned mine is located 13 miles southwest of New Tazewell on TVA property on a short peninsula between two branches of the Powell River Arm of Norris Lake. This was the largest lead mine ever to operate in Tennessee and was reported to have been worked as early as 1869. It has been idle since 1903 except for the periods during both World War I and World War II. To reach this old mine follow Tenn. 33 north from Maynardville, cross bridge over Norris Lake, then turn left in about 1 mile on Sharpe's Chapel Road, go about 1¼ miles, turn right and follow Lead Mine Bend Road several miles to Stiners Boat Dock, then turn right before the dock area is reached on an unimproved road and go about 1 mile to the old mine. The portal is about 25 feet above normal pool of Norris Lake. The main surface excavation is a large open cut extending to the underground workings, which average about 22 feet in height, 10 to 95 feet in width, and extend underground for about 550 feet. These old underground workings are very dangerous and should not be entered.

26

FOR MORE INFORMATION WRITE OR VISIT

Federal Bureau of Mines Liaison Office, 1109 Parkway Towers, Nashville, Tenn. 37219.

Tennessee Division of Geology, G-5 State Office Building, Nashville, Tenn. 37219.

Tennessee Division of Geology, East Tennessee Branch, 4711 Old Kingston Pike, Knoxville, Tenn. 37919.

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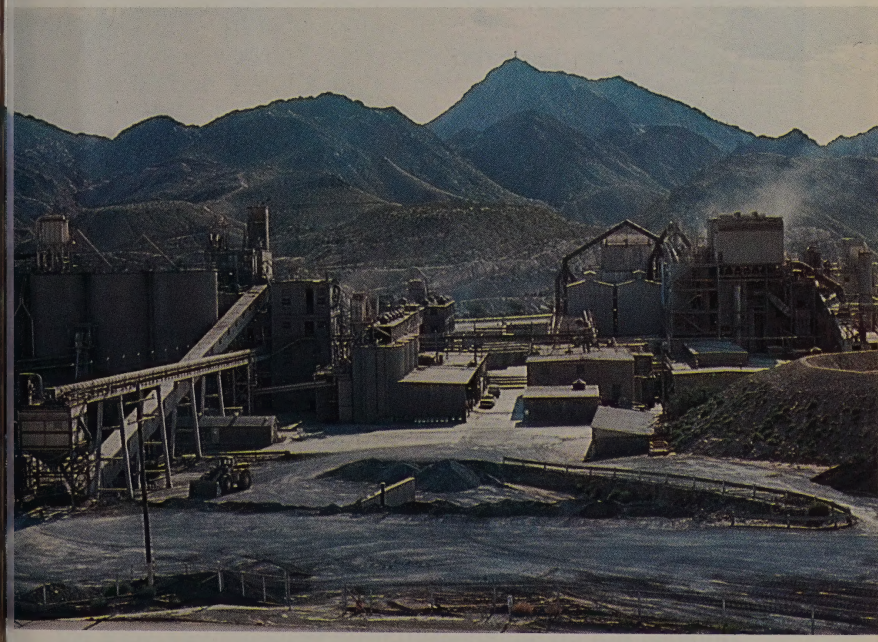
Ghost mining town of Terlingua, Tex.

TEXAS

by
Murphy E. Hawkins

For almost four decades, Texas has led the Nation in value of mineral production. The fact that Texas is the leading oil and gas producer with about 200,000 wells in over 10,000 fields is so widely acclaimed that it is legend. Because of this pervasive oil and gas syndrome, however, the existence of a broad base significant metal and nonmetal mineral industry in Texas remains virtually unknown. Few Texans, or other citizens for that matter, are aware that the State ranks in the Nation's top 10 nonfuel mineral producers with almost 500 active underground, open pit, and solution mines in 1975. Some important metallic and nonmetallic minerals produced from Texas underground and open pit mines include uranium, mercury,

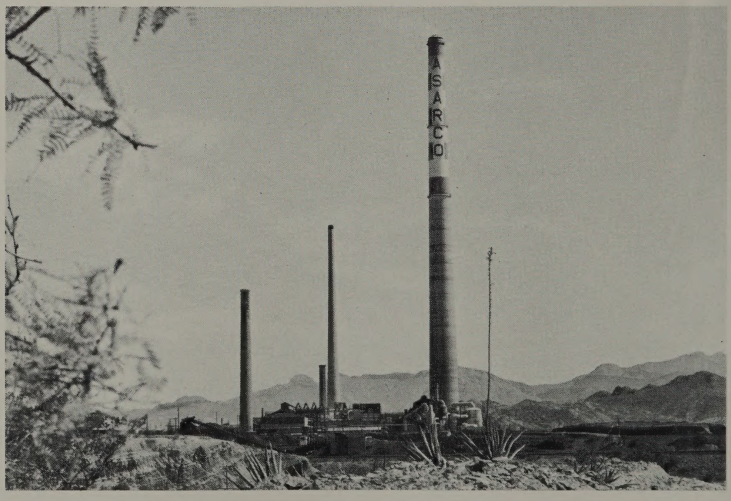


The Southwestern Portland Cement Co. plant in El Paso, Tex.

iron, salt, stone, clay, gypsum, limestone, talc, graphite, and sand and gravel. Other minerals such as sulfur, uranium, magnesium, sodium sulfate, and sodium chloride are produced by solution mining. After about 30 years of dormancy, Texas lignite or brown coal is again being mined to help meet the Nation's soaring energy requirements as oil and gas production fails to keep pace with demand. Lignite production in 1975 was almost 10 million tons, and production may exceed 20 million tons per year by 1980.

As you tour Texas via the State's excellent highway system, you will pass within viewing distance of hundreds of mineral operations. Visiting mineral operations is not limited to the open road. For example, a 50-mile drive along the ship channel between Houston and Galveston via Tex. 225 and Tex. 146 will take you alongside one of the largest aggregations of petrochemical, oil refining, steel, tin, and other mineral processing facilities in the world. Although fewer in number, similar mineral facilities are adjacent to the Beaumont-Port Arthur-Orange and Corpus Christi ship channels.

Smelters and refineries in El Paso, Amarillo, and Corpus Christi treat copper, lead, zinc, cadmium, gold, silver, and other precious metals. The Nation's largest antimony smelter is in Laredo, and the only tin smelter in the United States is in Texas City. Texas is the second largest producer of aluminum metal with alumina refineries and smelters at Point Comfort, Gregory, Rockdale, and Palestine. These smelters and refineries treat ores from other States and foreign sources.



ASARCO, Inc., smelter in El Paso, Tex. The mountains seen in the background are in Mexico.

This chapter provides information pertaining to selected mines, mills, oil fields, smelters, refineries, petrochemical plants and related mineral facilities that can be seen from public streets and highways. Index maps show the location of these facilities. It should be noted that only the "giant" oilfields; that is, fields having produced over 100 million barrels of oil or fields with historical significance are identified because the inclusion of all fields would make the publication too voluminous.

Please keep in mind that abandoned mineral operations are on still private property and you may violate Texas trespass laws if you enter without the owner's permission. Extreme caution should be exercised when visiting abandoned mining camps because most of the mine shafts and opencut mines are unprotected. Entering abandoned mine workings can prove to be fatal.

Terlingua cemetery with the abandoned mining camp in the background.

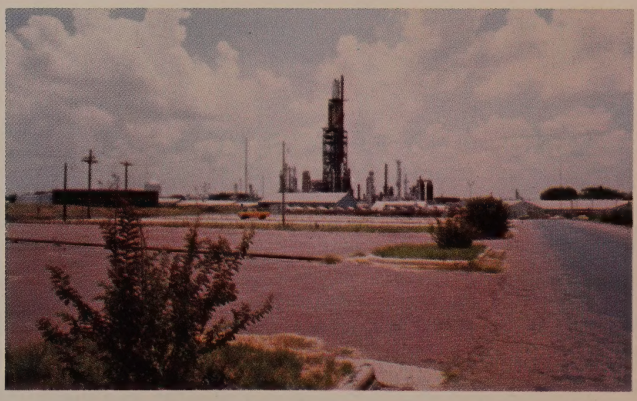
MINES AND PLANTS YOU CAN SEE FROM THE HIGHWAY

EASTERN TEXAS

Interstate 30, U.S. 67—Mount Pleasant.—The American Petrofina Co. of Texas operates a 26,000-barrel-per-day crude oil refinery in the southwestern part of the city. The tall steel structure, visible on the skyline, is a catalytic cracking unit that breaks down large complex hydrocarbon molecules into smaller more

useful ones. A catalyst is employed to accelerate the chemical reactions involved in the cracking process to produce a larger quanitity of gasoline base stocks of higher octane than is produced by thermal cracking. The refinery manufactures a variety of petroleum products such as gasoline, kerosine, diesel fuel, fuel oil, butane, propane, rubber solvent, and asphalt. On the north side of Interstate 30 west of Mount Pleasant, International Chemical Co., Inc., grinds and packages elemental sulfur that has been recovered from petroleum and natural gas produced in the area.

1 In May 1974, the Industrial Generating Co. (Texas Utilities) opened the Monticello lignite strip mine (map location 1). The mine is about 5 miles west of Mount Pleasant and 2 miles northeast of Winfield. The lignite produced here is a brownish-black coal of Wilcox age with a heating value of about 7,500 Btu per pound. Depth to the coalbeds in the mine area range from 20 to about 100 feet. Mining is conducted with "walking" draglines that are as tall as a five-story building. These large machines are equipped with booms that are 285 feet long and buckets that remove 65 cubic yards of dirt per bite. The Monticello operation employs the area mining technique, which means that a large land area is stripped by digging a series of contiguous flat-bottom trenches to expose the coalbeds. After the draglines have uncovered the coal, 16-cubic-yard power shovels operating in the pit dig the coal and load it directly into 100-ton haulers. Following removal of the coal, the trench is backfilled with the overburden from the next parallel cut. Mining by this method results in rows of conical shaped piles of earth. At this mine, however, modern reclamation of the mined land is practiced. The piles of earth are leveled with bulldozers, hauler-scrapers, or grading equipment. Farm-type machinery is then brought in to prepare the soil for revegetation with grasses and/or trees thus returning the land to other productive uses.



American Petrofina's Mount Pleasant crude oil refinery. The tall structure is the catalytic cracking unit. (Courtesy of American Petrofina Co. of Texas.)

EASTERN TEXAS

LEGEND

- Monticello lignite strip mine
- Lone Star Steel Co. iron ore mine and steel mill
- Henderson Clay Products, Inc., Marshall Pottery Co., and Marshall Tiles, Inc.
- Darco lignite strip mine
- Martin Lake lignite strip mine
- Eastman Kodak Co. chemical plant
- East Texas oilfield
- East Texas oilfield historical marker
- Statue of "Joe Roughneck"
- Alcoa aluminum smelter
- Hawkins oilfield
- Van oilfield
- Morton Salt Co. underground salt mine
- Amoco gas processing plant
- General Portland, Inc., cement plant
- Sand and gravel mining operations
- General Portland, Inc., quarry and plant
- Acme Brick Co. plant and clay pits
- Limestone quarries and aggregate crushing plants
- Acme Brick Co. clay pits and brick plant
- Thurber, scene of early-day coal mining
- Strawn Materials Co. lightweight aggregate plant
- Featherlite Corp. open pit mine and aggregate plant
- White's Mines, Inc., limestone quarries and aggregate plant
- Capital Silica Co. sand pits and plant
- Texas Lime Co. plants and quarry
- Round Rock Lime Co. quarries and plant
- Texas Industries, Inc., cement plant and quarries
- Gifford Hill & Co., Inc., cement plant and quarries
- Reliance Clay Products Co. brick plant and clay pits
- Corsicana, State's first oil boomtown
- Big Brown lignite strip mine
- 31— Universal Atlas Cement limestone quarry
- 32— Chemical Lime Co. limestone quarry and plant
- 33— Rockwool Industries, Inc., mineral wool insulation plant
- 34— Alcoa Sandow lignite strip mine
- 35— Capitol Aggregates and Texas Industries, Inc., sand and gravel pits
- 36— Austin White Lime Co. lime plant and quarries
- 37— Texas Crushed Stone Co. limestone quarry
- 38— Texas Quarries, Inc., plant and limestone mines
- 39— Texas Quarries, Inc., plant and quarries
- 40— Lone Star Industries dolomite and limestone quarries
- 41— Bilbrough Marble Co. stone quarry
- 42— Dean Word Co. dolomite quarry
- 43— Pure Stone Co. underground limestone mine
- 44— Texas Granite Corp. granite quarry
- 45— Texas Granite Corp. and Capitol Marble and Granite Co. granite quarries
- 46— Inactive crushing plant
- 47— Pennsylvania Glass Sand Corp. and CX Projects Corp. sand pits and plants
- 48— Bilbrough Marble Co. granite quarry
- 49— United States Gypsum lime plant
- 50— Parker Bros. & Co., Inc., quarry and aggregate crushing plant
- 51— Servtex Materials quarry and plant
- 52— Longhorn Cement plant and quarry
- 53— McDonough Bros. quarry and plant
- 54— McDonough Bros. limestone quarries
- 55— Dickey Clay Manufacturing Co. and Alamo Clay Products Co. pits and plants
- 56— Sand pits
- 57— D'Hanis Brick and Tile Co. clay pits and plant
- 58— White's Mines, Inc., basalt quarry
- 59— White's Mines, Inc., and Uvalde Rock Asphalt Co. natural asphalt quarry
- 60— Reynolds Mining Co. fluorspar flotation mill
- 61— Mine dumps from early underground mining
- 62— Tesoro Petroleum Corp. crude oil refinery
- 63— NL Industries antimony smelter and tungsten mill
- 64— Abandoned coal mine town of Dolores
- 65— Rio Clay Products pits and inactive brick plant
- 66— Fordyce Co. and Crow Gravel Co. sand and gravel pits and plants
- 67— Anchor gasoline plant
- 68— Port of Brownsville
- 69— Celanese Corp. chemical complex
- 70— Atlantic Richfield Co. uranium plant
- 71— Uranium ore processing mill
- 72— Conquista Uranium Project—open pit mines and uranium mills
- 73— Corpus Christi
- 74— Reynolds Aluminum Co. alumina refinery and aluminum smelter
- 75— Ingleside
- 76— Ashland Chemical Co. carbon black plant
- 77— Union Carbide and National Starch and Chemical Co. petrochemical plants
- 78— Alcoa alumina refinery and aluminum smelter
- 79— Balcones Minerals Corp. and Milwhite Co. clay pits and mills
- 80— Sand and gravel mining operations
- 81— Phillips Petroleum Co. crude oil refinery
- 82— Dow Chemical Co. magnesium extraction and chemical plants
- 83— Texasgulf, Inc., Frasch sulfur mine
- 84— Jefferson Lake Sulfur Co. Long Point sulfur mine
- 85— United Salt Co. underground salt mine
- 86— Conroe oilfield
- 87— Milwhite Co. clay pit and plant
- 88— Dresser Minerals clay processing plant

View of an opencut lignite strip mine; in the foreground is a power shovel loading lignite, and in the background, a walking dragline removes the overburden.

The produced coal is crushed and stored in silo-type facilities. Railroad hopper cars pass underneath the silos and are loaded with coal for transporting to the 1,500,000-kilowatt Monticello steam electric powerplant about 10 miles south of Winfield. At the powerplant, the lignite is ground to a fine powder and air-fired into the boiler where burning occurs almost instantaneously. All of the lignite produced at the Monticello mine is used to fuel the powerplant that generates electricity for Texas homes, businesses, and industries.

Most travelers are surprised to see a coal mine in Texas, but coal mining is not new to the State or to the Winfield—Mt. Pleasant area. Indeed, over 100 underground mines were in operation at various times from the late 1800's until the early 1940's. The last mine in the Winfield area closed in 1943. This mine was located northeast of the town. Other underground mines were east of the city and south of Interstate 30. These mines were developed by vertical shafts or slope entrances on the outcrops. Depths of the mines ranged from about 30 feet to 100 feet. Coal was mined by a modified room-and-pillar method. By robbing some of the support pillars before abandoning the mines, recovery in the underground operations ranged from about 50 to 70 percent, whereas the current strip mine operations recover about 90 percent of the coal in place. Underground haulage was by mine cars that were hand trammed or pulled by mule. The decline in Texas coal and lignite production is attributed to the economic squeeze resulting from shifts to a cheaper and more convenient fuel; namely, oil and natural gas. Consequently, by 1938 only eight lignite mines remained in operation. Total output of these mines were about 800,000 tons. In 1938, the average output for the 500 underground miners was less than 8 tons per man-day, compared with an average of over 55 tons per man-day for the Texas strip mines in 1972.

U.S. 259, FM 250—Lone Star.—The Lone Star Steel Co. recovers iron ore from the Weches Formation (Eocene) (map location 2). Limonite (iron oxide) and siderite (iron carbonate) are mined by the open pit method. Some of these open pits, which are often located on hills, can be seen along FM 250 between Lone Star and Hughes Springs. Limonite is widely distributed in the surface soil and can be seen in highway road cuts through hills in northeastern Texas. Draglines are used to strip the surface soil overlying the iron deposits, and these same draglines dig and dump the ore directly into trucks. The pit run ore is hauled to a beneficiation plant where it is concentrated by removing impurities such as rock, sand, and clay. The beneficiation plant is about 1 mile east of the town of Lone Star on FM 250. Iron concentrates along with coke and limestone are "cooked" together in a blast furnace to produce pig iron. The blast furnace is a 100-foot-tall black metal structure that can be seen in the north-central part of the steel complex. This "cooker" is called a blast furnace because a blast of hot air is injected near the bottom of the furnace to increase the combustion rate bringing the temperature of the charge to about 3,000° F. This intense heat converts the ore concentrates into pig iron, which is tapped from the bottom of the furnace. As slag and pig iron are removed, additional ore, coke and limestone are charged through the top of the furnace via a skip hoist. Pig iron from the furnace is converted into steel in open-hearth furnaces that are adjacent to U.S. 259. Lone Star is the only company in the State that produces iron and steel from native ore. Lone Star is one of the country's important manufacturers of oilfield tubular goods and also produces significant quantities of iron plates, bars, steel ingots, and cast iron pressure pipe.

2

U.S. 80, FM 1997—Marshall.—Henderson Clay Products, Inc., produces building bricks from clays of the Wilcox Group and the Reklaw Formation (map location 3). The brick plant is about 0.5 mile off of U.S. 80 on Franklin Street in the city. Bricks made at this plant are formed by machines that grind and mix stiff clay that is extruded through an opening onto a conveyor where a cutter slices the bricks to size. The raw bricks are then fired in kilns at temperatures from 1,500° to 2,000° F. This high temperature causes the clay particles to partially fuse together making the brick hard and strong. By selecting clays with different mineral content, or addition of coloring agents, the manufacturer can produce a wide variety of shades of brick. For example, by choosing a clay with a high iron content, a red brick can be produced. Some decorative face bricks are dusted with powdered

3

manganese or other minerals before firing to give them a distinctive appearance. The Marshall Pottery Co. manufactures flowerpots and ceramic specialty items at a plant on Lake Street just east of the brick plant. Marshall Tiles, Inc., produced a variety of ceramic wall tile at its plant on U.S. 80 adjacent to the Texas & Pacific railroad on the west edge of the city.

Tex. 43—Darco.—About 12 miles southwest of Marshall, ICI, United States, Inc., recovers lignite (brown coal) at their Darco strip mine (map location 4). This Wilcox Age coal is mined in the same way as at the Monticello strip mine near Winfield except the size of the mining equipment is much smaller. The lignite from this mine is not used for fuel but is hauled by truck to a plant on the east side of Marshall where it is processed into activated carbon. This is the oldest strip mine in the State; the mine has been in continuous operation since the mid-1940's.

4

Tex. 43—Tatum.—In 1975, the Texas Utilities Generating Co. began erecting a large dragline in preparation of opening the Martin Lake lignite strip mine (map location 5). Mining will be conducted in the same way as at the company's Monticello mine except the equipment will be larger. This mine will have a productive capacity of about 12 million tons per year when it is in full operation. The giant walking draglines are equipped with booms almost as long as a football field (295 feet) and with buckets that will remove 95 cubic yards of earth per bite. The lignite mined here is the same geologic age (Wilcox) as the lignites that are being mined at Darco and Monticello. Initial mining operations will begin about 3 miles south of Tex. 149, between Tatum and Beckville. During the next two decades, mining activity will move to the northeast, east, and south of the town of Beckville. The Martin Lake steam electric generating plant, which will have a generating capacity of about 3 million kilowatts, is about 5 miles southwest of Tatum near the community of Dirgin. Mining operations are scheduled to begin in 1976, and the powerplant is to begin operation about a year later. When the mine is in full operation, it will be the largest in the State and one of the largest in the Nation.

5

Interstate 20, Tex. 42—Longview, Kilgore, Turnertown.—On the southeast edge of Longview, south of Interstate 20 and east of Tex. 149, is the Eastman Kodak Co.'s Texas plant (map location 6a). This plant manufactures about 30 different chemicals and petrochemicals utilizing petroleum and natural gas produced in the state.

6a

West of Longview, Interstate 20 passes through the northern half of the world-famous east Texas oilfield (map location 6b). Since its discovery in 1930, the

6b

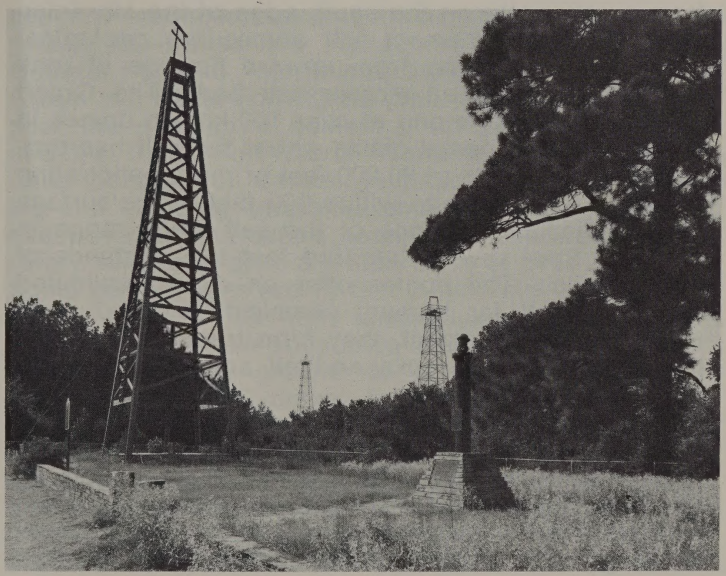
Aerial photograph of the Lone Star Steel Co. mill taken from the west. U.S. 259 passes adjacent to the plant on the east side of the steel mill. (Courtesy of Lone Star Steel Co.)

field has produced over 4 billion barrels of oil, which easily makes this field the Nation's top producer. In the later thirties, the field had over 30,000 producing oil wells and covered an area of 130,000 acres. Today, after nearly half a century of production, the field has about 13,000 producing wells and a productive area of over 67,000 acres. Oil production is from the Woodbine Sandstone (Upper Cretaceous) at an average depth of approximately 3,600 feet.

A historical marker located at Main and Commerce Streets in Kilgore relates the story of the feverish drilling activity in that city's downtown area (map **6c** location 6c). At one time, a one-block area in downtown Kilgore had the greatest concentration of oil wells in the world. Two miles east of Turnertown on Tex. 64 is a statue of Joe Roughneck dedicated to all oilfield workers and a replica of the early-day wooden **7** derrick of the type that was used to develop the east Texas field (map location 7).

U.S. 79—Palestine.—The Aluminum Co. of America's newest smelter is about 8 miles northeast of Palestine and 2 miles southwest of Neches (map location 8). The smelter, which began operating in 1975, can be viewed from an overlook on the east side of U.S. 79. The 15,000-ton-per-year plant employs a new smeltering process developed by Alcoa that consumes considerably less electricity than the conventional method. If the process proves successful, the smelter will be expanded to 300,000 tons per year, which will make it the largest in the United States. With this expansion, Texas should become the top aluminum producing State in the United States. The State currently ranks second behind the State of Washington. 8

U.S. 80—Hawkins.—The giant Hawkins oilfield, discovered in 1940, has produced over 400 million barrels of petroleum (map location 9). Oil production is from the Woodbine Sandstone (Upper Cretaceous) at an average depth of about 4,500 feet. In the town, oil wells are completed inside the walls of the abandoned Hawkins drugstore, between office buildings, cafes, in churchyards and schoolyards and on property belonging to lodges and cemeteries. Exxon's Hawkins Cemetery Assoc. Well No. 1 gives evidence of the wide variety of participation in the oil revenues from the Hawkins field. Reportedly, the membership of some oil-rich churches grew spectacularly after it was proposed to give some of the oil revenue to members. 9



Statue of Joe Roughneck and replica of wooden derrick and historical marker commemorating the discovery of the east Texas oilfield, Turnertown, Tex. (Courtesy of Texas Highway Department.)

Morton Salt Co.'s Grand Saline underground mine and salt processing plant.

10 **Interstate 20, Tex. 110-Van.**—The Van oilfield has produced over one-third of a billion barrels of oil since it was discovered in 1929 (map location 10). The field is still one of the top 20 oil producers in the State. Oil production comes principally from the Woodbine Sandstone (Upper Cretaceous) at a depth of about 2,900 feet. Some oil production is from the Nacatoch formation at a depth of about 1,200 feet.

11 **U.S. 80, Tex. 110-Grand Saline.**—Morton Salt Co. mines salt by both underground and solution methods from a salt dome on the south edge of the city (map location 11). Piercement salt domes are geological phenomena, resulting from upward flowage of rock salt from deepseated mother salt beds. The Grand Saline salt dome is one of over 100 known domes in the Texas gulf coastal plains where the salt has protruded from depths of 20,000 feet or more penetrating overlying formations to within 100 feet of the surface in some instances. Tops of the salt plugs range in diameter from several hundred feet to a distance of over 8 miles. The domes offer an almost unlimited supply of salt for human, chemical, and industrial uses. Just as important, they form traps for sulfur in the limestone cap rocks and oil and gas over the dome and on the flanks.

The Grand Saline salt plug is over 1 mile in diameter and rises to within 220 feet of the surface. At Grand Saline, mining began in 1931 at a depth of about 700 feet. The underground mine consists of two vertical entry shafts and several miles of horizontal workings. Salt is mined in checkerboard pattern (room-and-pillar method) leaving pillars to support the roof. Some rooms have ceilings 90 to 100 feet high.

The solution mines are on another part of the dome safely away from the underground operation. In solution mining, well bores are employed instead of mine shafts and brine is produced instead of rock salt. Simply stated, solution mining consists of injecting freshwater to dissolve the rock salt resulting in brine, which is then pumped to the surface. The produced rock salt and brine are processed for table, industrial, agriculture, and chemical purposes at a salt plant adjacent to Tex. 110 about 0.5 mile south of Grand Saline. Texas ranks second in the production of salt in the United States.

The only house built of rock salt in North America is on Garland Road (U.S. 80) in downtown Grand Saline. The walls of the house called the Salt Palace are made of large solid blocks of salt. The outer walls have been sprayed with a silicon water repellent to keep the salt blocks from melting during rains. An earlier salt house, built in 1930 to house the city library, had to be torn down because rains were causing the walls to erode.

U.S. 80, Tex. 19.—Amoco's gas processing plant is on Tex. 19 about 0.5 mile north of the intersection of U.S. 80 and Tex. 19 between Edgewood and Fruitvale (map location 12). Hundreds of tons of sulfur are removed from "sour" gas that is produced from wells completed in the Smackover Formation (Jurassic) at a depth of about 12,500 feet. Sour gas is a term given to natural gas that contains hydrogen sulfide. Hydrogen sulfide is highly toxic, has the odor of rotten eggs, and must be removed before the gas can be used for heating homes and office buildings. 12

U.S. 80—Dallas and Vicinity.—The Trinity Div. of General Portland, Inc., mines limestone of the Austin Group and Eagle Ford Shale (both Upper Cretaceous) near the company's cement plant between U.S. 80 and the Dallas-Fort Worth Turnpike in West Dallas (map location 13). Cement is manufactured by grinding and blending limestone, shale, and iron oxide in exact proportions before heating the mixture in giant rotary kilns (ovens) to a temperature of over 2,000° F. Some cement kilns are 12 feet in diameter and almost 500 feet long. This high temperature converts the mixture into a new substance called clinkers. When the clinkers are ground to a fine powder, they become cement. Gypsum is generally blended with the clinkers in the final grinding process to retard the setting rate of the cement. Texas Industries, Inc., operates a lightweight aggregate and concrete products plant just north of the Dallas-Fort Worth Turnpike at 1900 Chalk Hill Road. Eagle Ford Shale is mined from open pits and expanded in a rotary kiln to produce a lightweight aggregate that is sold under 13

the trade name Haydite. Also between Dallas and Fort Worth along the Trinity River floodplains are several large sand and gravel mining operations (map location 14). These mines and processing plants may be seen from the turnpike and local roads.

14

Loop 820—Fort Worth.—The Trinity Div. of General Portland, Inc., manufactures portland and masonry cement from Chico Ridge Limestone (Pennsylvanian) quarried near the plant and near Bridgeport (map location 15). Loop 820 passes through the limestone quarry just west of Cement Creek Reservoir about 1.5 miles west of the intersection with U.S. 81 and 287 on the north side of the city. The cement plant is east of Ten Mile Bridge Road and about 1 mile south of the quarry on Loop 820. The plant has three rotary kilns with a productive capacity of about 15 million sacks of cement per year.

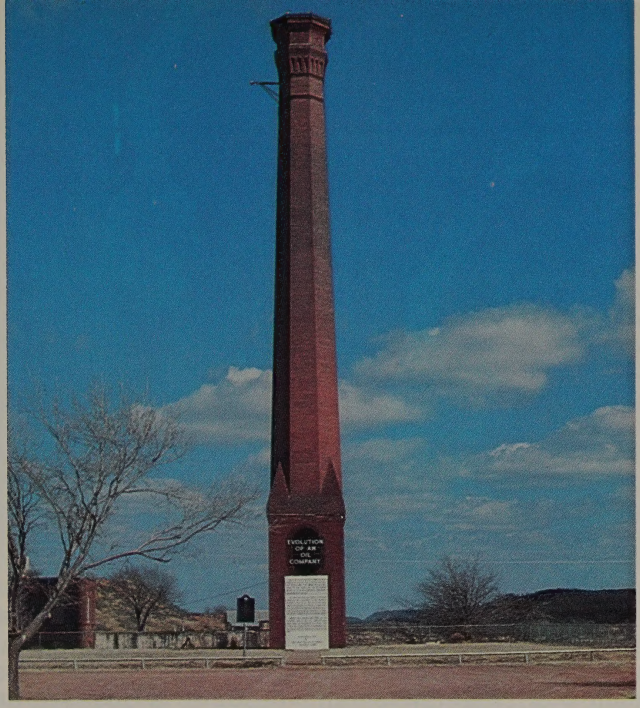
15

The Winston Refining Co.'s 20,000-barrel-per-day crude oil refinery is northeast of the intersection of Interstate 35W and U.S. 183. The refinery produces gasoline, diesel fuel, fuel oil, and other petroleum products.

Interstate 35, U.S. 377-Denton.—The Acme Brick Co.'s plant and clay pits are south and east of the highways on the south side of Denton. The plant produces face brick for construction purposes (map location 16).

16

Aerial view of General Portland, Inc.'s, Chico limestone quarries and crushing facilities about 6 miles north of Bridgeport, Tex. The town of Chico, Tex. 114, and FM 1810 can be seen northwest and north of the plant. (Courtesy of General Portland, Inc.)



Smokestack and historical marker at Thurber, Tex.

U.S. 380, FM 920—Bridgeport.—About 45 miles northwest of Fort Worth, some of the nation's largest limestone quarries and aggregate crushing plants are located (map location 17). The quarries are in the Chico Ridge Limestone (Canyon Group, Pennsylvanian). Most of the aggregate produced here is trucked or shipped by rail to the Dallas-Fort Worth area for use in the construction of homes, office buildings, streets, and highways. Other uses include flux stone, railroad ballast, and stone for manufacture of cement. Gifford-Hill's Perch Hill facility, with a yearly productive capacity of 3.2 million tons of crushed stone, is one of the largest and most automated plants in the area. Other plants that can be seen from U.S. 380 between Bridgeport and Chico are Texas Industries, Inc., Vulcan Materials Co., and Trinity Div. of General Portland, Inc. On the southwest edge of Bridgeport on FM 920 are the Acme Brick Co.'s clay pits and brick plant (map location 18). Clay of the Lake Bridgeport Shale (Pennsylvanian) is mined from open pits near the brick plant to manufacture building brick and structural tile.

17

18

Interstate 20—Thurber.—See the discussion of this coal mining town under "Ghost Towns and Mining Camps" (map location 19).

19

Tex. 16, Tex. 108—Strawn.—The Strawn Materials Co. operates a lightweight aggregate plant in the east edge of Strawn (map location 20). Strawn was also the scene of extensive bituminous coal mining in the early 1900's. The large mine dump of the Mt. Marion

20

mine is in the southwest edge of the city, and the mine dumps of the Strawn Coal Co.'s Nos. 2, 3, and 4 mines are about 2 miles north of the city and east of Tex. 16.

Interstate 20, U.S. 80—Ranger.—Featherlite Corp. mines shale of the Seaman Ranch beds (Pennsylvanian) to produce lightweight aggregate at a plant on the north edge of the city (map location 21). The shale, which has the characteristic to expand or "bloat" when heated to almost 2,000° F, is mined from open pits near the plant and west of the city. This low-density, high-strength aggregate is used extensively in concrete where light weight is desirable; that is, concrete building blocks. Some prestressed beams that support highway bridges and buildings contain this aggregate material instead of stone or gravel.

21

U.S. 377—Brownwood.—The large limestone quarries and aggregate plant of White's Mines, Inc., are on the southwest edge of the city on U.S. 377 (map location 22). Pennsylvanian limestone is quarried and crushed for use as concrete aggregate, bituminous and other aggregate, road material, filter or extender, flux stone, poultry grit, and mineral food and riprap.

22

U.S. 67.—Capital Silica Co. mines Paluxy Sand (Lower Cretaceous) about 1 mile north of U.S. 67 and 18 miles southwest of Cleburne (map location 23). The sand is processed at a plant for molding sand, pottery sand, and silica flour.

23

U.S. 67, Tex. 171—Cleburne.—Texas Lime Co. manufactures quicklime and hydrated lime at two plants near the city (map location 24). Plant No. 1 is on the south edge of Cleburne at the junction of Tex. 171 and Tex. 174. The company's No. 2 plant can be reached via U.S. 67 and park road 21 about 11 miles to the southwest near the Cleburne State Park. Edwards Limestone of Lower Cretaceous age is quarried near the No. 2 plant for feedstock for both plants. Lime (CaO) is a white substance that is formed by burning limestone ($CaCO_3$) in a kiln (oven) at a temperature of about 1,800° F. Lime is used for highway construction (as a soil stabilizer), mason's lime, refractory, agricultural chemical, and other purposes. In 1974, Texas ranked third in the Nation in lime production.

24

Tex. 174—Blum.—The Round Rock Lime Co. manufactures quicklime, hydrated lime and crushed aggregate from limestone and dolomite of the Edwards Formation (map location 25). The quarries and plant are about 4 miles west-southwest of the town.

25

U.S. 67—Midlothian.—About 25 miles southeast of Dallas, limestone of the Austin Group and Eagle Ford Shale (both Upper Cretaceous) are mined to produce portland and masonry cements. Texas Industries, Inc.,

Ruins of the first oil refinery west of the Mississippi River in Corsicana, Tex.

and Gifford Hill & Co., Inc., cement plants and quarries are located north and south of the city (map locations 26 and 27, respectively). In 1974, Texas ranked second among the States in cement production. These plants are among the Nation's largest with a combined production capacity of over 2 million tons of cement per year. 26 27

Interstate 45, U.S. 75—Ferris.—Reliance Clay Products Co.'s brick plant and clay pits are adjacent to Business U.S. 75 on the north edge of the city (map location 28). Face and common bricks are manufactured for building homes, offices, and for other construction purposes. 28

Corsicana became the State's first oil boomtown when oil was discovered accidentally while drilling a city water well in 1894 (map location 29). The shallow field is still producing oil after 81 years, and a few wells and equipment can be seen from the highway and local streets. Historical markers commemorating the city's role in the early development of the oil and gas industry in Texas and the Nation are in Petroleum Industry Park at 401 South 12th Street and at other sites in the city. On the south edge of the town is the Whiteselle brick plant that manufactures building bricks from Navarro clay (Upper Cretaceous) mined near the plant. Just north of Interstate 45 on U.S. 285, the Chattanooga Glass Co. produces glass containers from sands mined in Texas. 29

Interstate 45—Fairfield.—About 90 miles south of Dallas, the Texas Utilities Generating Co. operates the Big Brown lignite strip mine, one of the Nation's largest (map location 30). The lignite is a brownish-black coal of Wilcox Group (Tertiary) that ranks above peat and below bituminous. Mining is con- 30

ducted by removing the earth (overburden) from over the coal seam with two "walking" draglines. The giant machines, with 285-foot booms, remove 70 cubic yards of earth at a bite. Coal is loaded with 16-cubic-yard electric power shovels into 150-ton trucks that haul the coal via private roads to the Big Brown electric generating plant about 10 miles northeast of Fairfield. The land disturbed by mining is reclaimed by backfilling, grading, and revegetating thereby returning the land to other productive uses. The mine area begins about 2 miles north of Fairfield and extends 10 miles northeast to the 1,150,000-kilowatt Big Brown powerplant. This powerplant burns all of the coal mined here to provide electricity for Texas homes and industries. FM 488, FM 1124, and other county roads pass within viewing distance of the mining operations and powerplant.

U.S. 84—Waco.—About 1 mile south of U.S. 84 on the southwest edge of the city, the Universal Atlas Cement Div., United States Steel Corp., mines Eagle Ford Shale and Austin limestone (both Upper Cretaceous) to produce portland and masonry cement (map location 31).

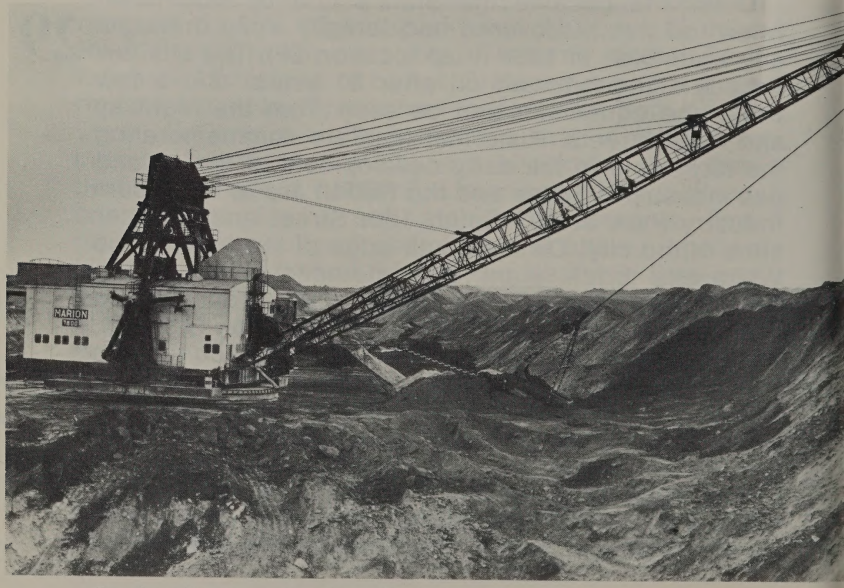
31

Tex. 6, FM 2602.—Chemical Lime Co., Clifton, produces lime from Edwards Limestone quarried near the plant site. The plant is about 2 miles south of Tex. 6 on FM 2602 (map location 32).

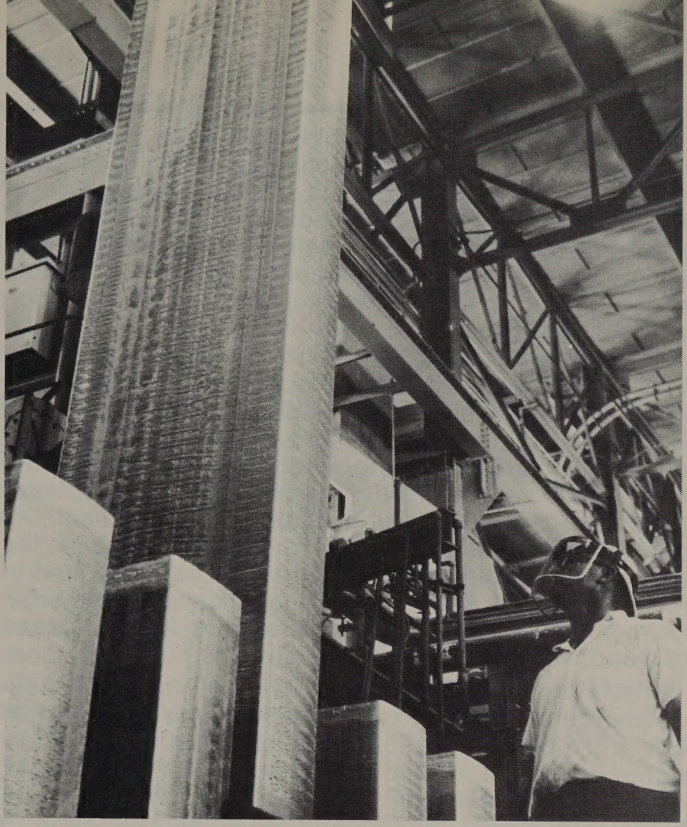
32

Interstate 35, FM 1741—Belton.—Rockwool Industries, Inc., produces energy saving bulk and batt insulation materials at a plant 0.5 mile east of Interstate 35 on FM 1741 near the Leon River (map location 33). Mineral wool is manufactured by a process similar to that used to produce cotton candy, but molten rocks

33



Sandow lignite strip mine, Rockdale, Tex. (Courtesy of Alcoa.)



A direct chill sheet ingot is pulled from its mold at Alcoa's Rockdale, Tex., works. The huge slabs of aluminum will be rolled into sheet and ultimately take the form of thousands of lightweight, modern consumer items. (Courtesy of Alcoa.)

are used instead of hot candy mix. The feedstock for the mineral wool mixture is basalt and slag from iron blast furnaces and copper smelters. The basalt and slag are melted using natural gas or coke. The Belton Sand and Gravel Co. mines sand and gravel from open pits along the Leon River flood plains east of the city. The company has a washing and screening plant about a mile east of the rock wool plant.

U.S. 77—Rockdale.—Sixty miles northeast of Austin and 6 miles southwest of Rockdale, the Aluminum Co. of America mines Wilcox lignite (brown coal) for fuel to generate electricity that is used to produce aluminum metal (map location 34). The coal is strip mined by the same method described at the Fairfield Big Brown mine. Rate of production is lower at this mine, consequently mining equipment—that is, draglines and shovels—are smaller. Both trucks and conveyor belts are used to transport the coal from the mine to the powerplant. Alcoa's 285,000-ton-per-year Rockdale aluminum smelter is the largest in the United States and one of the largest in the world. The mining area and smelter can be viewed from FM 1786 and FM 2116 that pass alongside the operations.

34

U.S. 183—Austin.—Capitol Aggregates and Texas Industries, Inc., mine sand and gravel from deposits adjacent to the Colorado River on the east side of Austin (map location 35). The large conical piles of rock and sand at the Capitol plant have been washed and screened for use as concrete aggregate and asphalt hot mix for highways and other construction purposes.

35

Interstate 35, FM 1325—Austin.—The Austin White Lime Co.'s plant and Edwards Limestone quarries are about 2 miles west of FM 1325 between Austin and Round Rock (map location 36). Lime has been produced at this McNeil site since the late 1800's. The remains of several vertical or shaft kilns that were used to produce lime until about 1905 are near the company's store about 200 yards southwest of the present lime plant. Cedar wood was used for fuel in the shaft kilns. Before natural gas became plentiful, the company experimented with burning lignite instead of wood.

36

Interstate 35—Georgetown.—About 3 miles south of Georgetown, the Texas Crushed Stone Co. quarries Edwards Limestone for production of aggregates, riprap, agricultural stone, flux stone, railroad ballast, and road material (map location 37). This modern, highly automated mining and crushing operation is one of the largest in the United States. Aggregate and other materials are shipped by rail to Houston and other gulf coast markets. Nearby markets are served by truck. Texas is the third largest producer of stone in the United States.

37

U.S. 183, FM 1431—Cedar Park.—About 2 miles west of the junction of U.S. 183 on FM 1431 are the Texas Quarries, Inc., plant and limestone mines (map location 38). Limestone of Edwards age (Lower Cretaceous) is mined to produce finished and semifinished dimension stone for the construction of homes and buildings. Three jib cranes at the plant and in the quarries serve as landmarks. Four other jib cranes can be seen in an inactive dimension stone quarry about 2 miles further west on FM 1431.

38

Tex. 29, Loop 332.—Liberty Hill.—A variety of dimension building stones are produced at Texas Quarries, Inc., plant in the southeast edge of Liberty Hill (map location 39). The stone is obtained at quarries several miles south of the town.

39

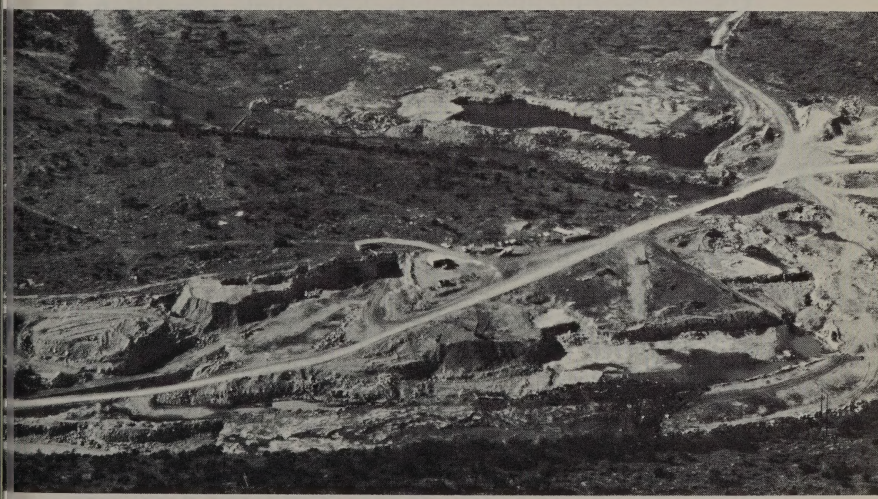
U.S. 281.—About 3 miles south of Burnet and about 0.5 mile east of the highway, Lone Star Industries quarries dolomite and limestone of Edwards formation (Lower Cretaceous) for the production of concrete aggregate, riprap, jetty stone, filter stone, flux stone, and road material (map location 40).

40

U.S. 281, Park Road 4.—Bilbrough Marble Co. quarries a variety of stone from several locations in this area to produce roofing granules, terrazzo chips, exposed aggregate, and other materials for construction and decorative purposes. The color of the rock material ranges from white through yellow, green, blue, red, and gray (map location 41). 41

U.S. 281, FM 1855.—Five miles north of Marble Falls, the Dean Word Co. mines dolomite from a quarry on the east side of U.S. 281 (map location 42). The dolomite is crushed for aggregate and for feedstock in the production of magnesium. 42

U.S. 281—Marble Falls.—The only underground limestone mine in Texas is the Pure Stone Co.'s operation about 0.5 mile south of the Colorado River on the east side of U.S. 281 (map location 43). Several tunnels (adits) into the underground workings are in the north and south high walls of the limestone quarry. Current underground mining activities are about 800 to 1,000 feet from the north quarry face toward the river. Mining is by room-and-pillar method with open stopes (rooms) that are about 20 feet high with a 30- to 40-foot face. Pillars are 20 to 30 feet in diameter. Limestone is mined by drilling shot holes in the face and shooting with ammonium nitrate prills fired by delayed electric detonator caps. The fragmented or broken stone is loaded into trucks by a front-end loader and hauled to the processing plant in Marble Falls. This white Ellenburger Limestone (Lower Cretaceous) is used as whiting (paint filler), poultry feed, and for chemical uses because of its high purity. 43



Pure Stone Co. quarry and underground limestone mine viewed from the north. Two entries (adits) into the underground workings can be seen in the center of the photograph. (Courtesy of General Land Office.)

Texas Granite Corp. quarry west of Marble Falls, Tex.

U.S. 281, FM 1431—Marble Falls.—About 1 mile west of Marble Falls on FM 1431, the Texas Granite Corp. operates a large quarry on the flank of Granite Mountain (map location 44). The State Capitol and many other state office buildings are constructed with pink granite from this site, which has been in continuous operation since the 1800's. At this quarry, large blocks of granite are cut from the face by drilling and channeling with jet flame lances and blasting. After the huge blocks are freed from the face, they are moved from the quarry by jib cranes that have lifting capacities of over 100 tons. Generally, the large blocks are sliced further by single or gang wire saws using a powdered silicon abrasive with water before they are loaded on railroad flatcars and hauled to the cutting and polishing plant about a quarter of a mile east of the quarry. In the plant, the granite blocks are shaped to the desired size, texture, and polish. The company produces a variety of architectural and memorial stones. A Texas roadside park of FM 1431 offers a vantage point for viewing the quarrying operations. Also at this park is a historical marker giving information about this 800-foot granite knob and quarry.

44

FM 1431—Granite Shoals.—Texas Granite Corp. and Capitol Marble and Granite Co. quarry granite at sites adjacent to the highway and within the community of Granite Shoals (map location 45). Large jib cranes at the quarries are prominent features on the skyline. Quarrying is conducted in the same way at these operations as described at the Texas Granite Corp. Granite Mountain quarry. Gray and pink granites from these quarries are processed into a variety of architectural and memorial stones. The imperfect granite blocks are used for riprap and jetty stones.

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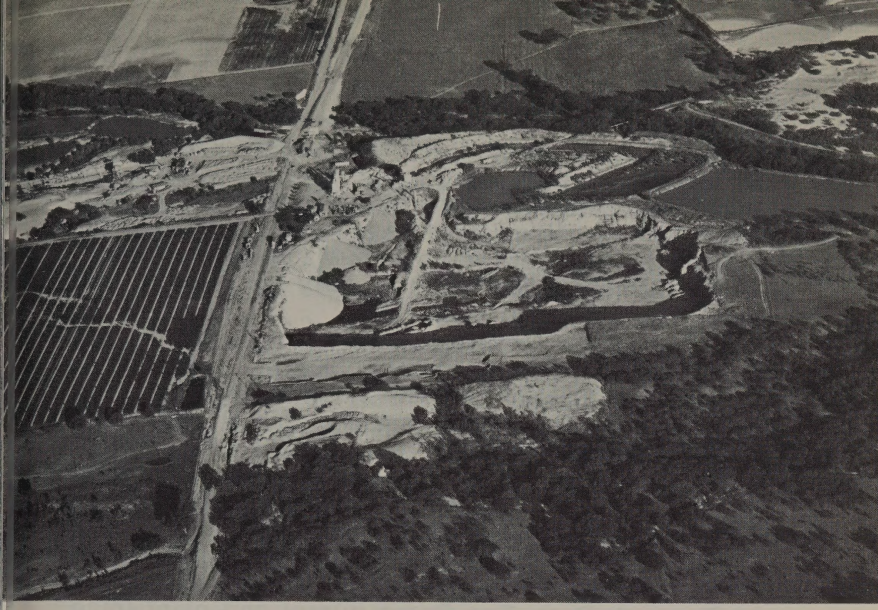


Sand plants and pits of CX Products Corp. and Pennsylvania Glass Sand Co. (Courtesy of General Land Office.)

Tex 16—Llano.—Two miles south of the city is the inactive Graphilter Corp. plant where Precambrian graphitic schist was crushed for use as filter media in municipal water systems and injection water for oilfield repressuring or disposal operations (map location 46). The Packsaddle schist was quarried south-southeast of the mill. 46

Tex. 71—Voca.—About a mile south of Voca on FM 1851 are the Pennsylvania Glass Sand Corp.'s and CX Products Corp.'s sand pits and plants (map location 47). The two plants wash, screen, and process Hickory Sandstone (Cambrian) for industrial uses such as oil well hydraulic-fracturing, blast sand, filtration sand, molding sand, pottery sand, pulverized sand, and silica flour. 47

U.S. 290, FM 965.—The Bilbrough Marble Co.'s granite quarry is on the flank of a granite knob about 3 miles north of Fredericksburg on FM 965 (map location 48). Quarrying is conducted in the same way as described at the Marble Falls and Granite Shoals operations. At a processing and polishing plant about a quarter of a mile from the quarry, the company manufactures a variety of architectural and monument stone from this highly desirable red granite. The imperfect blocks are sold for decorative stones or crushed for roofing granules. 48

Interstate 35, U.S. 81.—Between San Antonio and New Braunfels, several large limestone quarries can be seen along the Balcones escarpment west of the highways. All of these quarries are in the Edwards formation (Lower Cretaceous). The United States Gypsum Co. manufactures lime at a plant on the

49 south edge of New Braunfels (map location 49). Parker Bros. quarry and aggregate cruching plant are adjacent to the U.S. Gypsum's operation (map location 50). About 10 miles south of New Braunfels, Servtex Materials produces limestone for use as bituminous aggregate, flux stone, poultry grit, riprap, and other purposes (map location 51).

50

51

Interstate 35—San Antonio.—The Longhorn Cement plant is west of the highway about a mile north of Loop 410 (map location 52). Austin Chalk and Anacacho argillaceous limestone (both Upper Cretaceous) are quarried near the plant to manufacture cement. The cement plant and part of the large quarry just north of the plant can be seen from the highway.

52

U.S. 281, FM 1604—San Antonio.—About 1 mile north of the junction of FM 1604 on U.S. 281 is McDonough Bros. San Pedro quarry and plant (map location 53). Crushed aggregate produced from the Edwards Limestone (Lower Cretaceous) is used in the construction of highways, homes, and office buildings in the San Antonio area.

53

Interstate 10—San Antonio.—Interstate 10 passes between two large limestone quarries that cover over 250 acres about 15 miles northwest of the city (map location 54). McDonough Bros. mine limestone of the Edwards formation (Lower Cretaceous) to produce crushed aggregate and feedstock for the company's lime plant east of the highway.

54

Parker Bros. plant and limestone quarry just south of New Braunfels. Crushed stone is loaded directly into rail cars and transported by unit train to distant markets. (Courtesy of General Land Office.)

U.S. 181—Elmendorf.—The Dickey Clay Manufacturing Co. and the Alamo Clay Products Co. mine clays of the Wilcox Group to produce a variety of vitrified clay pipe products and building bricks (map location 55). The Alamo Clay Products' brick plant is in Elmendorf, and the Dickey plant is about 2 miles south of the town. 55

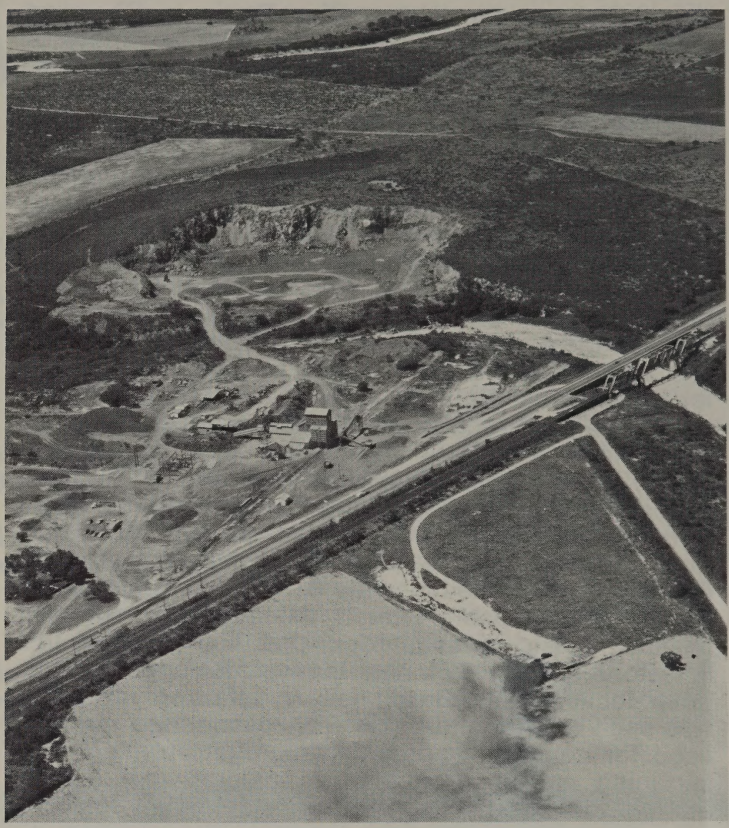
Tex. 16, U.S. 281—San Antonio.—Several companies, including Palo Alto Silica Sand, McDonough Bros., Star Sand Co., Harris Sand Co., Kite Sand Co., and Espey Sand Co. mine sand (Eocene) from open pits along Tex. 16 south of San Antonio to Poteet and to the community of Leming on U.S. 281 (map location 56). Most of the sand is washed and screened for use as filtration sand, hydraulic fracturing sand, and for other industrial applications. The remaining is used for construction purposes, generally without beneficiation. 56

U.S. 90—D'Hanis.—The D'Hanis Brick and Tile Co. mines clay from the Escondido Formation to manufacture building bricks, structural, floor, and drain tile (map location 57). The plant is on the west edge of the town north of the highway. 57

U.S. 90—Knippa.—White's Mines, Inc., quarries basalt, a basic igneous rock, that has intruded the limestone country rock near the western edge of town (map location 58). Basalt is a crystalized lava that was once red hot and liquid. This dense hard rock is used for concrete aggregate, aggregate for highway surfacing, and for production of mineral wool. In this quarry, the basalt has cracked and jointed to form columns similar to those that can be seen in Yellowstone National Park and Devils Post Pile National Monument south of Yosemite National Park in California. 58

U.S. 90, FM 1022.—Near Dabney, about 7 miles south of U.S. 90 on FM 1022, White's Mines, Inc., and Uvalde Rock Asphalt Co. quarry a natural occurring asphaltic limestone (map location 59). These rate deposits of bitumen impregnated Anaccacho Limestone (Upper Cretaceous) are used as a surfacing material for streets, roads, parking areas, tennis courts, playgrounds, warehouse floors, sidewalks, and for any other application where manufactured asphalt can be used. Texas ranks number one in the production of natural asphaltic rock. Mining of these deposits began almost 100 years ago. 59

Tex. 277—Eagle Pass.—The Reynolds Mining Co. produces acid-grade fluorspar at a flotation mill near the international railroad bridge on the south side of Eagle Pass (map location 60). The fluorspar (fluorite) ore is imported by rail from the Republic of Mexico. Eagle Pass was also the scene of early underground coal mining in Texas. Bituminous coal mining began 60



White's Mines, Inc., Knippa plant and basalt quarry on U.S. 90 west of San Antonio, Tex.

in 1849 when soldiers from Fort Duncan opened a mine to produce fuel for the military post. Later the railroad became the chief customer for the coal mined near Eagle Pass. In the late 1920's, the railroads switched to oil-fired engines, and the last mine closed. Mine dumps can be seen west of Tex. 277 between Seco Creek and the community of La Gloria about 2 miles north of Eagle Pass (map location 61). Other mine dumps are west of Tex. 277 and south of the junction of FM 1589 about 3 miles north of the city. The coal crops out along the Rio Grande River and, reportedly, is the origin of the name of Eagle Pass' sister city in Mexico, Piedras Negras, which means "black stones."

61

U.S. 83—Carrizo Springs.—About a mile north of Carrizo Springs is Tesoro Petroleum Corp.'s crude oil refinery (map location 62). The refinery processes about 13,000 barrels of oil daily from oilfields in the area into gasoline, diesel fuel, and heating oils.

62

Interstate 35, FM 1472—Laredo.—NL Industries antimony smelter on the north edge of the city is the largest in the United States (map location 63). The smelter, built in 1930, processes antimony ores from Mexico. Antimony is used in the manufacture of antimonial lead and the other hard-lead alloys. Principal use of this metal is in the production of automobile batteries. Some nonmetal uses include fireworks, fire retardants, plastics, ceramics, and glass. On the north side of the smelter and slag dump is a tungsten mill that began operation in late 1974. The mill processes ores from Guatemala. Tungsten metal is used for the filament in all incandescent electric lamps, but its largest uses are in the manufacture of metalworking machinery. The smelter and tungsten mill may be viewed from Interstate 35 and FM 1472. 63

The abandoned coal mine town of Dolores is about 16 miles northwest of Laredo off FM 1472 (map location 64). Large mine dumps and crumbling foundations are the only visible remains of this once-thriving village and mining area where over 5,000 miners were employed. Coal mining began in 1881 and ended in 1939 with the closing of the Dolores mine. The current energy crisis has revived interest in these volatile oil rich coals that are reported to be the largest cannel coal deposits in the United States. 64

U.S. 83.—Seven miles east of Rio Grande City is the Rio Clay Products clay pits and inactive brick plant (map location 65). Some of the white hills in this area contain beds of volcanic ash (dust) that came from eruptions in the Rocky Mountain area of the United States and Old Mexico millions of years ago. The soft, powdery, very fine volcanic ash is used as an insecticide carrier, cement admixture (pozzolan), and for making bricks. 65

U.S. 83.—Between LaJoya and Sullivan City, the Fordyce Co. and Crow Gravel Co. mine sand and gravel from deposits along the highway (map location 66). The large washing and screening plants of these companies provide most of the commercial-grade sand and gravel used in the construction of highways, homes, and office buildings throughout the Lower Rio Grande Valley. 66

U.S. 83—Mission.—The Anchor gasoline plant is on the south side of U.S. 83 west of Mission (map location 67). The plant extracts gasoline, butane, and propane from natural gas produced from wells that can be seen in the orange groves and vegetable fields along the highway. 67

Tex. 48, FM 1792—Brownsville.—From the intersection of Tex. 48 and Tex. 4 east into the Port of Brownsville are several mineral processing plants. operated by Combustion Engineering, Milwhite Inc., Delhi Sand and Founday Co., Penwalt, and Fosforo,

68 Inc. (map location 68). The plants grind, pelletize, or blend ores of manganese, barite, fluorspar, phosphate, and other minerals that are mined in Texas or imported from Mexico. Union Carbide's plastic and chemical plant and Marathon's offshore rig building facility are on the north and east side of the fenced port area. The giant oil drilling rigs and platforms under construction may be viewed from the highway on the way to Port Isabel.

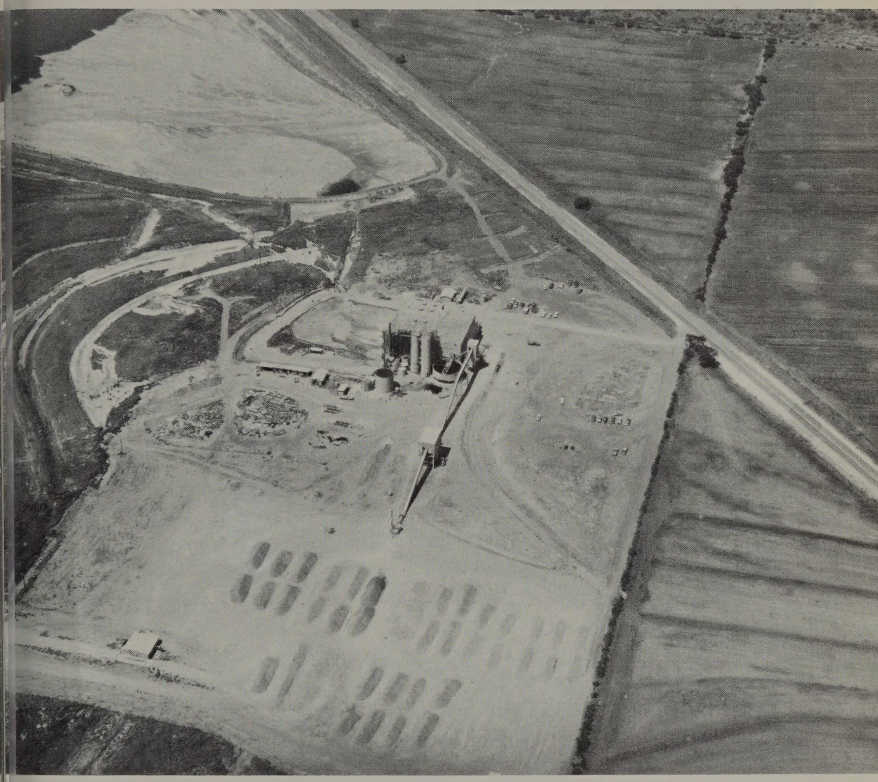
U.S. 77—Bishop.—The Celanese Corp.'s large chemical complex is between Bishop and Kingsville 69 on Business U.S. 77 (map location 69). Using petroleum and natural gas produced in the area, the company produces a wide variety of petrochemicals such as butyl acetates, formaldehyde, methanol, acetal copolymer resin, thermoplastic polyester, and trioxane.

U.S. 59—George West.—Atlantic Richfield Co.'s uranium plant is about 10 miles southwest of the city 70 on the north side of the highway (map location 70). This plant produces about $5 million worth of uranium oxide (yellowcake) per year from the Clay West uranium deposit. The uranium is recovered from the Oakville Sandstone (Miocene) at a depth of about 500 feet by in situ leaching. This in-place recovery method eliminates the need to remove the soil overlying the uranium ore body thus minimizing the disturbance of the surface. In situ mining of uranium involves the injection of a leachant or solvent into the uranium-bearing sandstone through input wells where the uranium oxide is absorbed and recovered through adjacent productive wells. The yellowcake is stripped from the pregnant leachant, dried, and packaged in 55-gallon drums for shipment to enrichment plants where it is processed into reactor fuel for electric generating plants.

Tex. 72, Tex. 9—Three Rivers.—Several companies including Exxon and Continental Oil Co. have mined uranium from open pits south of Tex. 72 on FM 1359 about 8 miles east of Three Rivers and about 3 miles southeast of the community of Ray Point. A uranium 71 ore processing mill is on Tex. 72 near the community of Ray Point (map location 71). The host rock for the uranium is the Oakville Sandstone (Miocene, Tertiary). Depths of the open pit mines in this area range from about 60 to 150 feet. Mining consists of removing the formations overlying the uranium-bearing sandstone with scraper-haulers. The ore is loaded onto trucks with front-end loaders and hauled to the uranium mill for crushing and processing. Uranium oxide or "yellowcake" is recovered at the Ray Point Mill by the carbonate leach process. The yellowcake, containing over 95 percent U_3O_8 is packaged in 55-gallon steel drums for shipment to enrichment plants for further

processing into reactor fuel for electric generating plants. The mines and mill may be observed from Tex. 72, FM 1359, and local roads.

U.S. 181, FM 791—Falls City.—The Continental Oil Co. and Pioneer Nuclear operate the Conquista Uranium Project about 60 miles southeast of San Antonio. The project is an integrated mining and milling operation that consists of numerous open pit mines and one of the Nation's most modern uranium mills. The Conquista mill, which began operation in 1972, is



Uranium mill at Ray Point on Tex. 72 viewed from the east. The white and dark area in the upper left corner of the photograph is the tailings pond. Uranium ore is stacked at the lower center of the photo. (Courtesy of General Land Office.)

5 miles west of Falls City on FM 791 (map location 72). In 1974, Texas ranked fourth in production of uranium. To date, uranium deposits have been discovered in Eocene and Miocene formations along a line extending from about 50 miles east of Austin to Rio Grande City, a distance of about 300 miles. Uranium open pit mines vary in size, but a typical one is about 350 feet wide and 1,000 feet long at the mine floor. The contiguous Butler, Weddington, Keller mines cover a distance of about 5 miles. Average uranium

72

Open pit uranium mine in Karnes County, Tex. Depth of the pit is about 120 feet. The uranium ore is the dark material being loaded into the trucks.

oxide content (U_3O_8) of the ore in the south Texas district is less than 4 pounds per ton. The mill and mines can be viewed from FM 791 and county roads.

Interstate 37, U.S. 181—Corpus Christi.—Known as the Sparkling City by the Sea, Corpus Christi is a heavily industrialized city with oil refineries, petroleum tank farms, petrochemical complexes, a zinc smelter, a cement plant, and other mineral processing facilities that are located alongside the ship channel (map location 73). Entering the city from the west on Interstate 37, or on Up River Road for a closeup look, will take the traveler by Sun Oil's 60,000-barrel-per-day Suntide refinery, Saber Petroleum Corp.'s crude oil refinery (currently under construction), and Asarco, Inc.'s, electrolytic zinc-cadmium smelter. Zinc-cadmium ore concentrates are imported from foreign sources. Asarco's 300-foot red and white smokestack serves as a reference point. Quintana-Howell's 47,000-barrel-per-day refinery is at the corner of Navigation and Up River Road east of Asarco. Coastal States 170,000-barrel-per-day refinery is on Cantwell Lane. PPG Industries, Inc., produces chlorine, soda ash, liquid and solid caustic soda, potassium hydroxide, and chrome chemicals at its plant on Lawrence Drive. Brine feedstock (sodium chloride) is mined by solution methods at the Palangana salt dome and transported by pipeline a distance of about 40 miles to the plant. On east of PPG are the Southwestern Oil and Refining Co.'s and Champlin Petroleum Co.'s oil refineries that have 116,000- and 68,800-barrel-per-

73

day capacities, respectively. The storage capacity of the large flattop tanks near the refineries range from about 4 million to over 12 million gallons each. These tanks are used to store crude oil and low-volatile refined products such as gasoline, jet fuel, heating oil, and diesel fuel. The spherical tanks are used for high-pressure storage of liquified petroleum gases such as propane and butane. Proceeding north on U.S. 181 over the high bridge and west on Navigation Boulevard is the Centex Cement Corp.'s plant that manufactures portland and masonry cement from oystershells dredged from shallow bays and clay mined from open pits across the bay near Portland. Benilite Corp. of America's plant is north of U.S. 181. The plant produces synthetic ilmenite and titanium oxides. These products are used in paints, varnish, lacquers, paper, and plastics.

ASARCO, Inc., electrolytic zinc smelter at Corpus Christi, Tex. Quintana-Howell refinery, Coastal States, PPG, and other industries can be seen toward the high bridge. (Courtesy of ASARCO, Inc.)

Tex. 361, Tex. 35.—Southeast of the city of Gregory, the Reynolds Aluminum Co. refines imported bauxite ores to produce alumina and, in an adjacent smelter, converts the alumina into aluminum metal (map location 74). The large flat-topped mounds of red materials that can be seen near the plants are U.S. Government-owned stockpiles of bauxite.

74

Tex. 361—Ingleside.—Between Ingleside and Gregory is the E.I. du Pont de Nemours & Co.'s Freon Products plant (map location 75). The plant, one of the largest in the United States, produces refrigerants and aerosol propellents from petrochemicals and hydrogen fluoride. On the east and south edge of Ingleside is Exxon's tank farm, and south of the tank farm is the Good Hope Chemical Co.'s new fertilizer plant. The plant has a productive capacity of 2,500 tons of anhydrous ammonia fertilizer daily. Southeast of Ingleside on FM 2725 is the Sun Oil tank farm, Baker Marine, and National Steel Co.'s facilities.

75

Tex. 35.—Between Rockport and Aransas Pass is the Ashland Chemical Co.'s carbon black plant (map location 76). This furnace-type plant produces carbon black from liquid hydrocarbons for use in the manufacture of synthetic rubber.

76

Tex. 35, Tex. 185—Seadrift.—Union Carbide and National Starch and Chemical Co. have petrochemical plants on Tex. 185 between Tex. 35 and Seadrift (map location 77). The plants manufacture a variety of products such as acetylene, polyethylene resins, ethylbenzene, styrene, butyraldehyde, diethanolamine, diethylene glycol, diethylene glycol monoethyl ether, ethoxytriglycol, ethylene glycol, ethylene glycol monoethyl ether, ethylene oxide, 2-ethylhexanol, isobutanol, monoethanolamine, polyamine-T, triethanolamine, butadiene, ethylene, and propylene.

77

Tex. 35—Point Comfort.—Aluminum Co. of America operates an alumina refining plant and aluminum smelter just south of the city (map location 78). Bauxite, the ore of aluminum, is imported from foreign sources and is processed into aluminum metal at this large integrated facility.

78

Interstate 10, U.S. 90—Flatonia.—Balcones Minerals Corp. and the Milwhite Co. process bentonite clay and fuller's earth at mills about a mile west and north of the town of Flatonia, respectively (map location 79). Clays of the Jackson Group (Eocene) are mined from open pits near the mills and west of FM 154 between Flatonia and Tex. 71. A rail loading facility is in the town of Muldoon. The processed clay is used as an additive for oil well drilling mud, oil and grease absorbent, foundary and steelwork refractories, and filtering and decolorizing agent. In 1974 Texas ranked second in tonnage of clay produced in the United States.

79

Bentonitic clay mine near Flatonia, Tex. The scraper and rubber-tired dozer are removing about 30 feet of overburden above a 3- to 6-foot bentonitic clay bed.

Interstate 10, Tex. 71—Columbus.—Extensive sand and gravel mining operations can be seen south of Interstate 10 along the Colorado River and along Tex. 71 south to Altair and to Eagle Lake via U.S. 90A (map location 80). In 1974, Texas ranked fourth in the production of sand and gravel, and Colorado County was the State's top producer. Principal companies in the area with mines and plants are Parker Bros., Inc., Gifford-Hill & Co., Inc., Horton & Horton, Inc., Thorstenberg Materials Co., Inc., and Lone Star Industries, Inc. Sand and gravel is mined with draglines and dredges from Beaumont strata (Cenozoic). After beneficiation, which includes washing and screening, the products are shipped by rail or truck to Houston and other gulf coast cities to build homes, office buildings, shopping centers, streets, and highways. **80**

Tex. 35—Old Ocean.—The Phillips Petroleum Co.'s 85,000-barrel-per-day crude oil refinery is at this community about 8 miles south of West Columbia and 16 miles north of Bay City (map location 81). Tex. 35 passes through the Old Ocean oil and gas field, which has produced about 100 million barrels of oil and almost 200 billion cubic feet of natural gas since the field was discovered in 1934. Oil and gas production is from the Frio Formation (Miocene) at depths of about 10,000 feet. **81**

82 **Tex. 288—Freeport.**—The Dow Chemical Co.'s plant A and plant B are on the south and north edges of Freeport (map location 82). For over 30 years, Dow has been extracting magnesium, a light strong metal, from seawater and more recently from dolomite ($CaMgCO_3$) at plant B. The company also makes a variety of plastics and petrochemicals from petroleum feedstock, natural gas, and brine (NaCl). The brine is produced by solution mining from nearby salt domes.

83 **Tex. 59, FM 1301.**—At the town of Newgulf, about 15 miles southeast of Wharton on FM 1301, is the Texasgulf, Inc., largest Frasch sulfur mine (map location 83). The Boling salt dome, also known as Newgulf, is the top producer of sulfur of all the gulf coast domes; the Boling salt dome yielded over 70 million long tons, which is five times more than its nearest rival. Sulfur is recovered from wells drilled into the sulfur-bearing limestone cap rock at depths ranging from about 900 to 1,200 feet. Since production began in 1929, thousands of wells have been drilled in a relatively small area because several holes are usually required to recover the sulfur under each acre. Frasch sulfur mining employs the same well for both injection and recovery purposes. This is accomplished by installing three sets of pipes concentrically so that hot water (over 300° F) can be injected between the outer and inner pipes into the top of the sulfur-bearing formation. The melting point of sulfur is about 240° F. Therefore, this superheated hot water melts the sulfur, which flows to the bottom of the hole where it is airlifted to the surface through the inside pipe.

84 **Tex. 36,—FM 1994.**—The Long Point sulfur mine is about 15 miles south of Rosenberg and 4 miles northeast of the town of Guy (map location 84). The mine, owned by Jefferson Lake Sulfur Co., produces sulfur by the Frasch process from a depth of about 1,700 feet. The sulfur storage and shipping facilities and the hot water plant may be viewed from the highway and local roads.

85 **U.S. 290—Hockley.**—The United Salt Co.'s Rockhouse underground mine is on the Hockley salt dome about 4 miles south of the town and about 31 miles northwest of Houston (map location 85). Since 1932, salt has been mined by the room-and-pillar method at a depth of about 1,500 feet. This is the State's deepest shaft mine. The rock salt produced here is crushed and screened for ice cream salt, animal feed, and other agricultural and industrial uses. Salt from this mine is not refined for table use. The company produces evaporate salt for human consumption at its Blue Ridge salt mine and plant on the southeast edge of Houston.

Interstate 45, Tex. 105—Conroe.—The famous Conroe oilfield, discovered in 1931, has produced over 500 million barrels of oil and is still one of the top 20 oilfields in the State (map location 86). Oil production is from Eocene sands at an average depth of about 5,200 feet. A historical marker about 5 miles southeast of the town, near the Four Corners area, gives a brief account of the early days of the giant Conroe oilfield. It was in the vicinity of this marker that well blowouts occurred resulting in the formation of large craters that swallowed up the drilling rigs and equipment. As a rule, the gushing oil and gas would catch fire and burn uncontrolled for weeks or months at a time. Blowouts and wild wells were common occurrences on the gulf coast during the 1920's and 1930's before drilling technology and equipment were perfected to control the abnormally high subsurface formation pressures found in this area. 86

Tex. 19—Riverside.—About a half mile northwest of Tex. 19 on FM 980, the Milwhite Co. produces bentonitic clay from large open pit mines (map location 87). The clay of Catahoula Formation (Tertiary) is processed in a plant on the Missouri Pacific Railroad in Riverside. The product is marketed for insecticide and fungicide carrier, drilling muds additive, filtering and decolorizing agent, and absorbent. 87

U.S. 69—Zavalla.—About 10 miles south of Zavalla, near the Angelina County line, bentonitic clay and fuller's earth of Jackson Group (Tertiary) are recovered from several large open pit mines. The clay pits are on local roads 1 to 2 miles west and southwest of U.S. 69 near the Neches River (map location 88). Dresser Minerals has a clay processing plant on the east side of the highway about 4 miles south of Zavalla at Dolan station on the Texas & New Orleans Railroad. The processed clays are used as an additive in oilfield drilling muds, insecticide carriers, oil and grease absorbents, and as a decolorizing agent. 88

WESTERN TEXAS

U.S. 287—Acme.—Georgia Pacific Corp. produces wallboard, plaster, portland cement retarder, joint compounds, and textures at a plant about 6 miles west of Quanah (map location 89). Gypsum of the Cloud Chief Group (Permian) is quarried north of the plant site. 89

Interstate 20—Sweetwater.—The Flintcote Co. and United States Gypsum Co. quarry Cloud Chief Gypsum (Permian) is about 1 mile east of the city (map location 90). Some of the white gypsum beds are near the surface and can be seen in the highway cut adjacent to the Flintcote mine and Sweetwater Creek. The mineral gypsum is a hydrate of calcum sulfate 90

A quarry shovel loads gypsum into rail cars for hauling to a wallboard plant near Sweetwater, Tex.

($CaSO_4.2H_2O$) that is so soft that it can be scratched with the fingernail. When heated, gypsum loses most of its water and becomes plaster of paris. This is the material that doctors use to make casts when they set broken bones. Further heating drives off all the water and produces plaster, which is used to manufacture wallboard. Gypsum is also used as a filler in paints, candy, animal feed, and as a retarder in portland cement. In 1974, Texas ranked third in production of gypsum in the United States.

FM 608—Maryneal.—About 20 miles south of Sweetwater, Lone Star Industries quarries Edwards formation limestone to produce portland cement at its Maryneal plant (map location 91).

91

Tex. 70, FM 57—Longworth.—Celotex Corp. quarries Cloud Chief Gypsum (Permian) just north of Longworth (map location 92). The gypsum is crushed and transported by rail to the company's wallboard plant at Celotex about 6 miles southwest of Hamlin (map location 93).

92

93

Tex. 70—Rotan.—The National Gypsum Co. quarries gypsum in the Cloud Chief Group (Permian) northwest of town off Tex. 70 (map location 94). The company manufactures wallboard and plaster at a plant in Rotan.

94

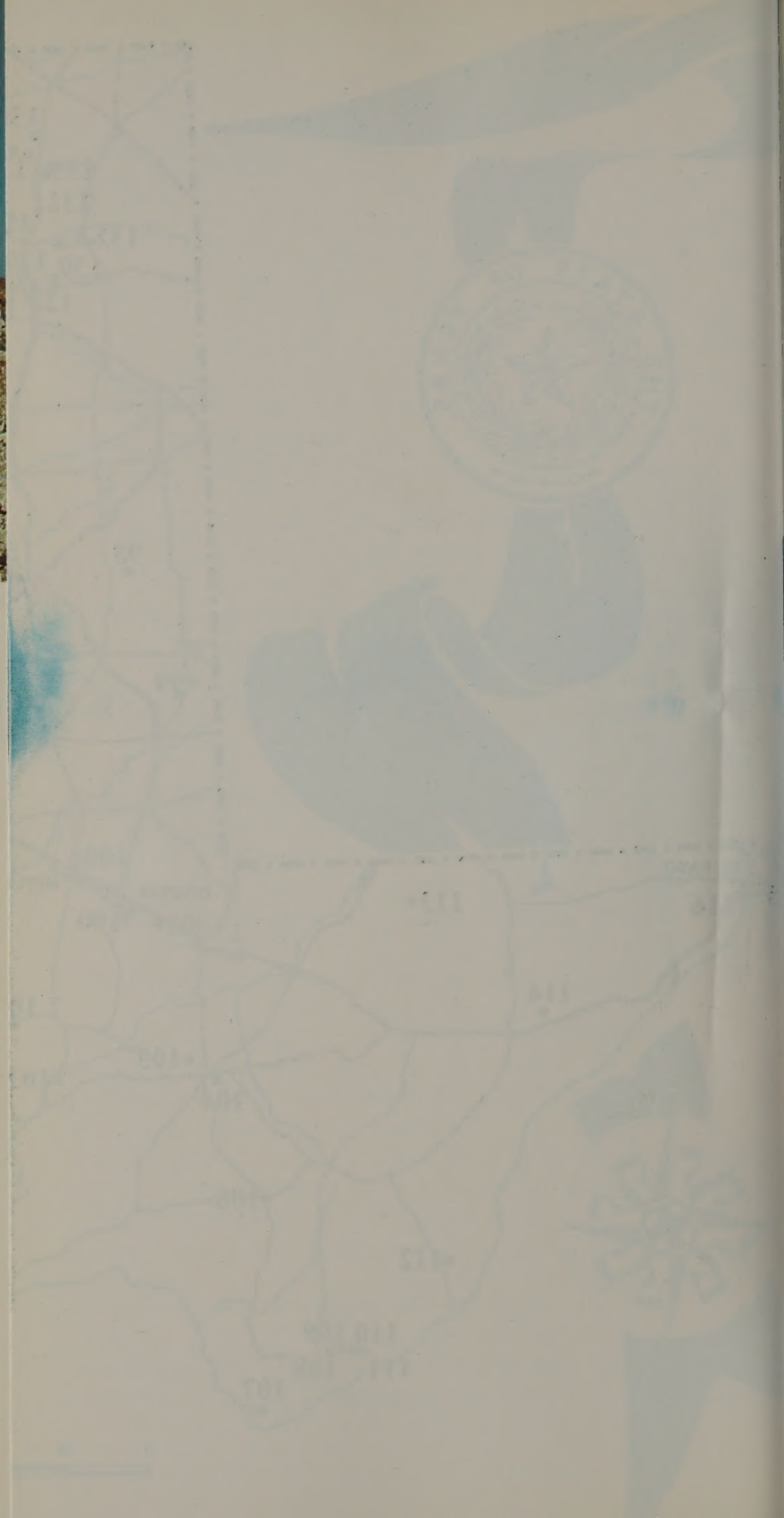
U.S. 84, U.S. 180—Snyder.—West and northwest of the city is the Kelly-Snyder oilfield, one of the Nation's largest. Production is from Canyon Reef Limestone (Pennsylvanian) at a depth of about 6,800 feet. The field has produced over 750 million barrels of oil since it was discovered in 1948. In October

95

WESTERN TEXAS

LEGEND

89— Georgia Pacific Corp. gypsum quarry and plant
90— Flintcote Co. and United States Gypsum Co. quarries and plants
91— Lone Star Industries limestone quarry and cement plant
92— Celotex Corp. quarry
93— Celotex Corp. wallboard plant
94— National Gypsum Co. gypsum quarry and plant
95— Snyder area
96— Cosden refinery and chemical complex
97— Sextuple oil well
98— Levelland-Slaughter oilfield
99— Vulcan Chemical Co. plant
100— Shell Oil Co. refinery, Rexene Polymer Co. and El Paso Products Co. petrochemical plants
100a— Permian Basin Petroleum Museum
101— Southwestern Portland Cement Co. quarries and plant
102— Big Lake oilfield
103— Yates oilfield
104— Stockton Salt Corp. solution salt mines
105— Atlantic Richfield Co. Frasch sulfur mine
106— Marathon
107— Ruins of Marischal mercury mine
108— Deserted Study Butte mercury mine and camp
109— Abandoned 248 mercury mine and camp
110— Town of Terlingua and mine ruins
111— Waldron mercury mine
112— Shafter, abandoned silver mine
113— Duval Corp. Frasch sulfur mine
114— Talc mines and mills
115— Asarco, Inc., smelter
116— Phelps Dodge electrolytic copper refinery
117— Border Steel Co.
118— Ashland Chemical Co. carbon black plant
119— El Paso Natural Gas Co. processing and compressor station
120— Cabot Corp. carbon black plant
121— Celanese Corp. petrochemical complex
122— Cabot Corp. inactive carbon black plant
123— Phillips Petroleum Co. petrochemical complex, crude oil refinery, and carbon black plant
124— Camex Inc. anhydrous ammonia plant
125— Phillips Petroleum Co. crude oil refinery
126— Alibates National Monument—Flint Quarry
127— Helium Monument
128— U.S. Department of the Interior, Bureau of Mines helium bottling plant
129— Asarco, Inc., electrolytic copper refinery
130— Southwestern Portland Cement Co. plant
131— Western Sand and Gravel Co. plant and gravel pits
132— Bivens natural gas compressor station of Colorado Interstate Gas Co. and U.S. Department of the Interior, Bureau of Mines helium plant
133— Phillips Petroleum Co. helium and natural gas liquids plant
134— Potash Co. of America plant
135— Diamond Shamrock Corp. crude oil refinery
136— Phillips Petroleum Co. ammonium nitrate plant
137— Phillips Petroleum Co. helium and natural gas liquids plant



1973, a well in this field produced the one billionth barrel of oil from Scurry County. The production facilities of. this well are painted gold, and a historical marker has been erected to commemorate the event. The well is about 3.5 miles northwest of Snyder at the junction of FM 1611 and U.S. 84. The Sun Oil Co.'s gas processing plant is 1.5 miles north of U.S. 180 on FM 1611. The Monsanto natural gas processing plant is on FM 1606 about 8 miles west-southwest of the city. The Southwestern Brick and Tile Co. manufactures building brick and structural tile at a plant on FM 1605 midway between U.S. 180 and Tex. 350 in the south part of the city. Clays of the Dockum Group (Triassic) are mined from open pits near the plant.

United States Gypsum wallboard plant at Sweetwater, Tex.

At a smelter on FM 1607 about 5 miles southwest of the city, the American Magnesium Co. produces magnesium metal and chlorine from brines pumped from shallow wells in the vicinity of Gail in Borden County. The Borden County brines contain over 20 times more magnesium than seawater, which is also a source of magnesium. The highly mineralized brines were formed by rainwater that has leached minerals salts from surface soils and subsurface rocks. The waters containing these leached minerals were then trapped in landlocked (playa) lakes where the concentration took place by solar evaporation.

96 **Interstate 20—Big Spring.**—About 5 miles east of Big Spring is the 65,000-barrel-per-day Cosden refinery and chemical complex (map location 96). Adjacent to the Cosden complex are the Cabot Corp.'s and Sid Richardson's furnace-type carbon black plants. Carbon black, a petrochemical, is a fine soot that is over 90 percent carbon. Its principal use is in the manufacture of rubber products and printing inks. Miscellaneous uses include chemicals, foods, and plastics.

97 **U.S. 84, U.S. 380—Post.**—The world's only oil well with six pumping jacks running head to head drawing oil from six different productive levels is on 13th Street in the northwest part of the town (map location 97). Oil production in the Garza Field comes from the Glorieta and San Andres formations at depths ranging from about 2,900 to 3,600 feet. Along the highways entering and leaving the city, you can see other multiple completions as well as the common single pumping jack.

98 **Tex. 116—Levelland.**—Between Levelland and Whiteface you will drive through the Levelland-Slaughter oilfield, which has produced over 200 million barrels of oil since the field was discovered in 1945 (map location 98). Oil production is from the San Andres Formation (Permian) at a depth of about 5,000 feet. Because of the flat, treeless terrain, pumping jacks and oil storage tanks dot the horizon as far as the eye can see.

99 **Tex. 214, Tex. 83—Denver City.**—The giant Wassom oilfield, which has produced about 700 million barrels of oil since it was discovered in 1937, surrounds this city. Oil production is from the San Andres and Clear Fork Limestone (Permian) at depths ranging from 5,000 to 7,500 feet. The Vulcan Chemical Co. produces brine by solution mining from Permian salt beds at a depth of about 2,500 feet (map location 99). Thick beds of rock salt, laid down during the existence of what is called the Permian Sea approximately 200 million years ago, underlie much of west Texas from below Fort Stockton to the northern part of Kansas, a distance of over 700 miles. The produced

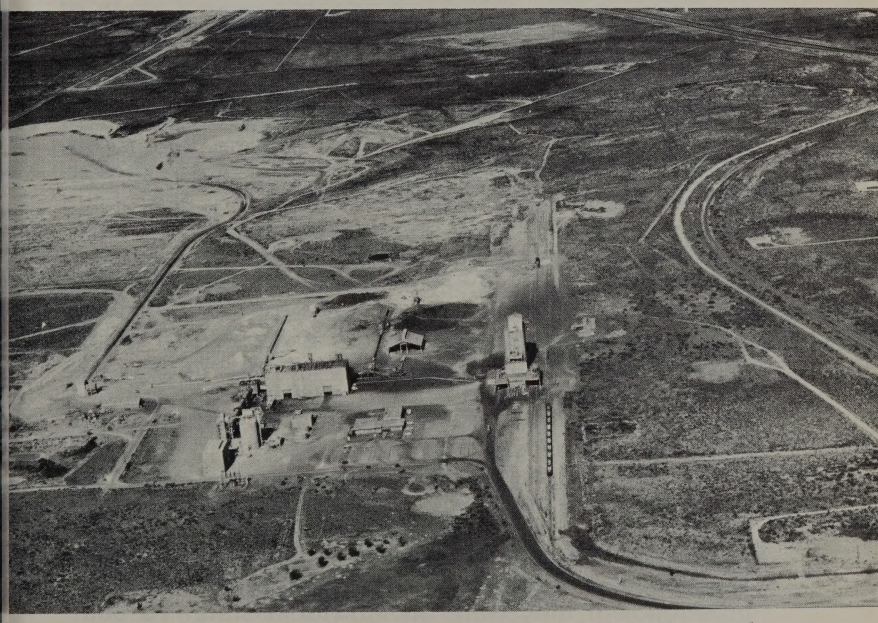
brine is used to manufacture caustic soda and hydrochloric acid at a plant that can be seen from Tex. 214 and Tex. 83. Also, cavities are leached in the underground salt beds for storage of millions of gallons of liquid petroleum gases, such as butane and propane.

Interstate 20, U.S. 385—Odessa.—In an industrial complex south of the city is the 32,000-barrel-per-day Shell Oil refinery, which produces gasoline, jet fuel, kerosine, fuel oil, benzene, and liquified petroleum gas (LPG) products (map location 100). The Rexene Polymer Co. and El Paso Products Co., also in this complex, manufacture petrochemicals from natural gas and natural gas liquids. Just north of Interstate 20 on the east side of Odessa is the Getty Oil Co.'s Headlee gas processing plant. This plant extracts natural gas liquids from natural gas produced in the area.

100

Interstate 20, Tex. 349—Midland.—The Permian Basin Petroleum Museum, Library, and Hall of Fame grounds are on a 40-acre site in Midland located on the north service road of Interstate 20 and just west of Tex. 349 (Lamesa-Rankin exits, map location 100a). Museum exhibits tell the history of the petroleum industry in the Permian basin; its geologic formation, discovery, and subsequent production are brought to life in pictures, sound, maps, and three-dimensional dioramas. Exterior exhibits include early-day cable tool and rotary rigs, multiple well completions, and the Marathon Oil Co.-University of Texas

100a



Southwestern Portland Cement Co. plant between Odessa and Penwell, Tex. (Courtesy of General Land Office.)

102 well No. 2, the second well completed in the famous Big Lake oilfield (see Big Lake, map location 102). President Gerald R. Ford dedicated the museum and library on September 13, 1975. An admission fee is charged.

Interstate 20—Penwell.—East of Penwell, the Southwestern Portland Cement Co. manufactures cement from Edwards Limestone and clay (both Lower Cretaceous) mined near the plant (map location 101). West of the cement plant is the inactive Sid Richardson channel-type carbon black plant. The carbon black plant, built during World War II, was closed in 1971 because of air pollution problems and obsolesence.

101

U.S. 67—Big Lake.—The Big Lake oilfield is about 13 miles west of the town near the townsites of Texon and Santa Rita (map location 102). The field has produced over 125 million barrels of oil and condensate since it was discovered in 1923. Several historical events and industry firsts are associated with this field. For example, the discovery well, Texon Oil & Land Co.'s Santa Rita No. 1, was of historical significance to the petroleum industry because it marked the first major oil find in the vast Permian Basin of west Texas and eastern New Mexico. Initial production was about 100 barrels per day from the San Andres Formation at a depth of about 3,055 feet. It was also the first oil well completed on the 2.5 million acres of land owned by the University of Texas. In 1928, a deep test in the field established the first oil production in the Ellenburger Formation at a depth of about 8,500 feet, which was the world's deepest productive well at that time. Early wells completed in the Ellenburger reservoir produced a peculiar water-white oil that was later determined to be gas condensate and not crude oil. This is the first instance where the retrograde phenomena was recognized in a reservoir. Historical markers are near the discovery site of the Big Lake field in Texon about a mile south of U.S. 67.

102

Large volumes of saltwater accompany the production of oil and condensate from the Big Lake field. As was the common practice of that era, this brine was poured on the surface of the land resulting in large areas of waste lands devoid of all vegetation. This practice was stopped some years ago, and today, produced water is reinjected into subsurface formations. Since the discovery of the Big Lake field, 270 other fields have been discovered on University of Texas lands, which have produced 1.2 billion barrels of oil. Today about 90,000 barrels of oil is produced daily from wells on University of Texas lands, which would make the lands the eighth-ranking State in oil production if they were an individual state. To commemorate the importance of the Santa Rita No. 1 dis-

covery to the University of Texas, the rig used to drill this well was dismantled and moved to the University of Texas-Austin campus in 1940. Under the sponsorship of the Texas State Historical Association, the derrick base, wooden walking beam, bull wheel, and related equipment were erected in a small park between M.L. King Boulevard and Trinity and San Jacinto Streets on the south side of the campus.

Oil well with early-day pumping equipment in the Big Lake field. Historical markers at the well site tell the history of this famous field.

Tex. 349, Tex. 29—Iraan.—The famous Yates oilfield was discovered in October 1926 when a wildcat well blew in while drilling at a depth of about 1,000 feet (map location 103). The main oil productive reservoir is the Greyburg Limestone (Permian), which lies at depths ranging from 1,000 to 1,500 feet. Wells in the Yates field had initial capacities among the greatest, if not the greatest, of any wells ever drilled. Initial production tests of one well drilled in 1929, 3 years after the field was discovered, had a daily potential in excess of 200,000 barrels. Eight years after the field was discovered and after the field production had passed 200 million barrels, another well was completed that had a productive capacity in excess of 168,000 barrels of oil per day.

103

About 2 years after the field was discovered, oil was observed on the surface of the Pecos River and seeping from outcrops along the river bank. Individuals and companies immediately began a mad scramble to recover this oil by skimming it from the river, drilling shallow wells, and digging open pits and trenches. Analyses of the oil seeps were identical with the oil produced from the Yates Formation and gave evidence of migration of oil to the surface and near surface sands through imperfect well casing installation.

In 1946, about 20 years after the field was discovered, oil was also discovered in several shallow sands ranging in depth from 100 to 600 feet in the northwestern part of the field. Discovery of this shallow oil led to a second extensive casing repair program aimed at sealing leaks in the deeper wells. Over 1,000 wells were eventually drilled to these shallow sands to recover this "escaped" oil. Scavenger oil recovery from surface seeps, trenches, and open pits were abandoned in the late 1960's. However, some "seep oil" is still being recovered from shallow wells completed in charged sands and gravel beds less than 100 feet deep along the Pecos River banks and in the flood plains. Cumulative oil production from the skimming operations, open pits, and shallow wells in the Toberg-Yates field area has amounted to over 36 million barrels. As of January 1, 1975, production from the main Yates pool has exceeded 600 million barrels. The town and oilfield are named after Ira and Ann Yates, owners of the large cattle ranch where oil was first discovered.

Interstate 10—Fort Stockton.—On the west edge of the city about 0.5 mile south of Interstate 10, the Stockton Salt Corp. recovers salt by solution mining from Permian salt beds at a depth of about 2,250 feet (map location 104). In solution mining, well bores are used instead of mine shafts. Freshwater is injected through wells into the salt bed to dissolve the rock salt. The resulting brine is then pumped to the surface. At this operation, the produced brine is evaporated in earthen pits or used in oil and gas drilling and production operations. Evaporated salt is recovered for cattle feed and other agricultural purposes. Permian salt beds underlie a large portion of west Texas from the Fort Stockton area to northern Kansas and westward into eastern New Mexico. The Atlantic Richfield Co. operates a Frasch sulfur mine about 8 miles north-northeast of Fort Stockton off FM 1053 (map location 105). Elemental sulfur is recovered from the Rustler Formation (Permian) by injecting hot water at a temperature of over 300° F into the sulfur-bearing limestone beds. The melted or liquefied sulfur is then pumped to the surface. Depth

104

105

Ruins of the Study Butte mercury mine. Remains from the operations up to the time of World War II are in the foreground. The steel structure in the background is the condensing unit from the last mining operation that ended in 1971.

of the bedded sulfur deposits range from 300 to 800 feet.

U.S. 90, Tex. 385.—Marathon is a rail shipping point for fluorspar (fluorite) and other minerals that are mined in the Big Bend country and adjacent areas of old Mexico (map location 106). Loading facilities and stockpiles of minerals are along the tracks on the east and west edges of town. Fluorspar is used as a flux in smelting aluminum and steel. It is also used in refining uranium and for the production of hydrofluoric acid. **106**

Big Bend National Park.—The Mariscal mine ruins and ghost mining camp are in the south-central area of the park (map location 107). See discussion of the Mariscal mine under Ghost Towns and Mining Camps. **107**

Tex. 118—Study Butte.—The Study Butte mercury mine and ghost mining camp are just north of the highway and the village of Study Butte (map location 108). See discussion under Ghost Towns and Mining Camps. **108**

FM 170—"248" Mercury Mine.—The 248 mercury mine and ghost camp are about midway between Study Butte and Terlingua (map location 109). See discussion of this mine under "Ghost Towns and Mining Camps." **109**

FM 170—Terlingua.—The Terlingua ghost town and mine ruins are about 5 miles west of Study Butte (map location 110). See discussion under Ghost Towns and Mining Camps. **110**

FM 170—Waldron Mercury Mine.—The Waldron mercury mine is about 2 miles west of Terlingua and about 1 mile north of a county road (map location 111). See discussion under Mines You Can Visit.

111

U.S. 67—Shafter.—The abandoned silver mine, mill, and mining camp are near the town of Shafter about 33 miles south of Marfa and 19 miles north of Presidio (map location 112). See discussion under Ghost Town and Mining Camps.

112

Overview of the town of Shafter with the ruins of the Presidio Mining Co. silver mill in the foreground.

FM 652.—Approximately 20 miles west of Orla is the world's largest Frasch sulfur mine. The Duval Corp. recovers sulfur from bedded deposits in Permian strata at an average depth of about 600 feet (map location 113). The mine and plant have a capacity to recover about 1.5 million long tons of sulfur per year. The sulfur is transported by unit trains hauling 100 tank cars or more to the port of Galveston, a rail distance of about 900 miles.

113

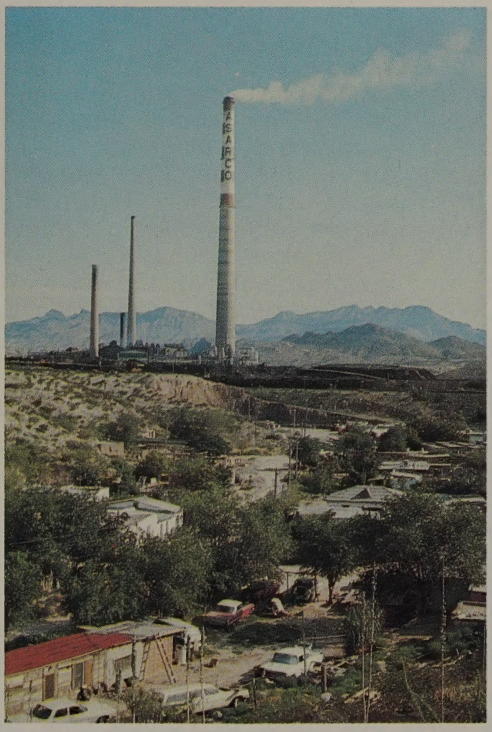
Interstate 10—Van Horn.—Some of the Nation's largest talc deposits are in the Allamoore Formation (Precambrian) along the flank of the Sierra Diablo mountain range north of Interstate 10 from Van Horn to about 12 miles east of Sierra Blanca (map location 114). There are about 40 active and inactive open pit mines, some of which can be seen at a distance from

114

the highway. Talc grinding mills are at Allamoore and about 5 miles east of Van Horn. Primary crushing and loading facilities are adjacent to the railroad west of Allamoore. Talc is a soft mineral that can be scratched with the fingernail and feels greasy or soapy. The talc mined here is used in ceramics and paint, not in cosmetics, although cosmetics use talc, too. About 9 miles west of Van Horn and 2 miles east of Allamoore is the Gifford Hill & Co., Inc., Holley plant and rhyolite quarry. Metarhyolite has been quarried at this location for over 30 years. Crushed aggregate from this plant is used as railroad ballast, roofing granules, and highway pavement aggregate.

Interstate 10, U.S. 80A—El Paso.—The 828-foot red and white smokestack marks the location of Asarco, Inc.'s, large custom smelter on the northwest edge of the city between Interstate 10 and U.S. 85 (map location 115). The smelter recovers copper, lead, and zinc from ores mined in other States and Mexico. An acid plant produces hundreds of tons of sulfuric acid each day from sulfur dioxide gases emanating from the pyrometallurigical processes. This smelter has been in continuous operation since 1887 and is one of the largest custom smelters in the Nation. North of the smelter at the intersection of U.S. 85 and Executive

115



ASARCO, Inc.'s, giant copper, lead, and zinc smelter on the northwest side of El Paso adjacent to Interstate 10 and U.S. 85. The smokestack is 828 feet tall. The mountains in the background are in Mexico.

Drive, Southwestern Portland Cement Co. manufactures cement from Lower Cretaceous limestone and shales mined in the area. Most of the buildings, streets and highways in this part of the State contain concrete made from cement produced at this plant. Phelps Dodge produces pure copper bars and rods from smelter-grade copper at its electrolytic refinery just east of the Chevron Oil refinery on Trowbridge Street (map location 116). This plant has a refining capacity of 4.5 million pounds of copper per year making it one of the world's largest copper refineries. Chevron Oil Co.'s 71,000-barrel-per-day crude oil refinery and Texaco Inc.'s 17,000-barrel-per-day refinery are also on Trowbridge Street in the east part of the city just south of Interstate 10.

116

Interstate 10—Vinton.—The Border Steel Co. is about 3 miles south of the New Mexico-Texas State line (map location 117). At this mill, scrap iron is melted in electric furnaces to produce reinforcement bars and other metal shapes.

117

Interstate 40, FM 1802—Shamrock.—Ashland Chemical Co. produces carbon black at a furnace-type plant 7 miles east of Shamrock and 0.5 mile south of Interstate 40 on FM 1802 (map location 118). Carbon black is manufactured by burning liquid hydrocarbons in an environment containing insufficient oxygen to support complete combustion. Consequently, the hydrogen atoms are almost completely burned whereas most of the carbon is precipitated as a solid soot residue. The carbon residue is black, hence the name carbon black. The principal uses of carbon black are in the manufacture of synthetic rubber for tires and printers ink. This carbon black plant is in the eastern edge of the giant Panhandle oil and gas field that extends west to Dumas and north into Oklahoma, a distance of over 150 miles.

118

Interstate 40.—The El Paso Natural Gas Co. operates a large natural gas processing and pipeline compressor station about 0.5 mile north of Interstate 40 on the Wheeler-Donley County line (map location 119). Natural gas from wells in the Panhandle oil and gas field is compressed and discharged into large-diameter pipelines to begin its long trek to customers in Texas and other States.

119

U.S. 60—Pampa.—The Cabot Corp. manufactures carbon black from liquid hydrocarbons at a furnace-type plant about 3 miles southwest of Pampa (map location 120). Cities Service extracts natural gas liquids from natural gas at a plant on U.S. 60 about 1 mile west of the Cabot plant. The Celanese Corp. produces a variety of petrochemicals at a large complex about 6 miles southwest of Pampa near the small town of Kings Mill (map location 121). Oil and gas

120

121

processed or used by these plants is produce from wells in the Panhandle field.

Tex. 152.—Skellytown.—Natural gas liquid extraction plants of Skelly, Kerr McGee, Dorchester, Northern Natural and Shell can be seen along Tex. 152 between Skellytown and Pampa. Cabot Corp.'s inactive channel-type carbon black plant is on the north edge of Skellytown (map location 122). All these facilities process or burn oil or gas produced from wells in Panhandle oil and gas fields. **122**

Tex. 136, 207, 152—Borger.—Towers, tanks, and smokestacks of petroleum and petrochemical facilities dominate the skyline of this city. Phillips Petroleum Co. has nine plants in the area that include a 99,000-barrel-per-day crude oil refinery, a petrochemical complex, and a furnace-type carbon black plant. The Phillips petrochemical complex and the world's largest carbon black plant are on Tex. 136 about 3 miles west of the city (map location 123). J. M. Huber Corp. also has a carbon black plant adjacent to the Phillips plant on FM 1559. Camex Inc. produces anhydrous ammonia at a plant on FM 1551 near the southwest edge of the city (map location 124). The Phillips crude oil refinery is northeast of the main business district (map location 125). **123** **124** **125**

Phillips Petroleum Co.'s 99,000-barrel-per-day crude oil refinery and natural gas liquids processing center at Borger, Tex. (Courtesy of Phillips Petroleum Co.)

Tex. 136—Fritch.—Six miles west of the town is the Alibates National Monument-Flint Quarry, the only national monument in Texas (map location 126). The quarries were first used by aborigines some 12,000 years ago. The quarry sites are shallow depressions or pits in the hilltop surrounded by chips of multicolored Alibates flint. In addition to the quarries, the monument area also contains prehistoric rock carvings and ruins of Indian villages that were occupied more than 500 years ago. The quarries may be visited only by National Park Service guided tours. The tours are available on a first-come-first-served basis daily from Memorial Day through Labor Day and on weekends in May, September, and October. At all other times, tours are given by request only. Tours are free and begin at the Bates Canyon Information Station at the Lake Meredith Recreation Area. Further information may be obtained by writing the National Park Service, P. O. Box 325, Sanford, Tex., or by calling (803) 865-3322.

126

Interstate 40—Amarillo.—A Helium Monument is at the intersection of Interstate 40 and Nelson Street in Amarillo (map location 127). The monument is a six-story stainless steel time column, which was erected in 1968 to commemorate the 100th anniversary of the discovery of this unusual element found in natural gas produced in the Amarillo area. Adjacent to the monument is a tourist information center that houses historical and scientific data. The information center is open daily from 10 a.m. to 6 p.m. The U.S. Department of the Interior, Bureau of Mines, has a helium bottling plant on Helium Road near the west edge of Amarillo between Interstate 40 and U.S. 66 (map location 128). The Bureau of Mines also operates a helium extraction and purification plant at Exell 33 miles north of Amarillo on U.S. 87 and an underground helium storage field about 10 miles northwest of Amarillo near the community of Cliffside. Until the late 1950's, the Bureau of Mines was the sole producer of helium in the United States. Since that time, several private companies have built helium recovery plants in the United States.

127

128

About 10 miles north of Amarillo on Tex. 136, Asarco, Inc., operates one of the Nation's newest and most efficient electrolytic copper refineries (map location 129). This refinery processes copper metal produced at the smelter in El Paso and smelters in other States. In addition to refining copper, the plant will recover silver, gold, platinum, palladium nickel salts, and compounds of selenium and tellurium. Asarco also owns an inactive zinc smelter on the northwest edge of the city that was closed in mid-1975. The horizontal retort smelter was shut down because of obsolescence and air pollution problems. On the east

129

International helium time column and pavilion in Amarillo, Tex.

side of the city between Interstate 40 and U.S. 66 on Grand Avenue is Texaco's 20,000-barrel-per-day crude oil refinery.

Interstate 40—Bushland.—The Southwestern Portland Cement Co. manufactures portland and masonry cement from an impure caliche and calcareous clay bearing sands (Cenozoic) that are mined in the vicinity of the plant (map location 130). The plant is about 1.5 miles north northwest of Bushland and can be seen in the distance from Interstate 40. **130**

U.S. 385.—The Western Sand and Gravel Co.'s Tascosa plant and gravel pits are along the Canadian River near the junction of U.S. 385 and FM 1061 (map location 131). Extensive mining operations have been conducted along the river north and south of the plant and particularly in the vicinity of Ady about 10 miles south of FM 1061. **131**

U.S. 287, U.S. 87—Masterson.—The Bivens natural gas compressor station of the Colorado Interstate Gas Co. is at Masterson about 16 miles south of

Federal Bureau of Mines helium bottling facility west of Amarillo between Interstate 40 and U.S. 66 on Helium Road.

132 Dumas (map location 132). West of the compressor station about 0.5 mile is the Exell helium plant that is operated by the U.S. Department of the Interior's Bureau of Mines. The plant extracts helium from natural gas produced from the Cliffside gasfield near Amarillo. Gasfields in the Amarillo area contain about 2 percent helium by volume and are currently the world's most important source of this unique element. The key to the extraction of helium from natural gas lies in the extremely low temperature at which it remains in a gaseous state. Consequently, a helium extraction plant is essentially a series of deep freezers where the temperature of the helium-bearing nat-

Federal Bureau of Mines Exell helium plant south of Dumas near Masterson, Tex.

ural gas is lowered as it passes through several stages of cooling until it finally reaches the "cold box" where the final temperature is dropped to 260° F below zero or colder. By this time, propane, which liquifies at −44° F, ethane, at −128° F, and methane, at −259° F, have been siphoned from the stream as liquids. The remaining gas is crude helium, which contains some nitrogen. This crude helium is piped to a government-owned underground storage field near Amarillo. Most people are familiar with the use of helium in toy balloons and lighter-than-air craft such as blimps and dirigibles. The principal uses of helium, however, are in the space program, in controlled atmospheres, in growing crystals for transistors, in processing cells for nuclear energy, for aerodynamic research, cryogenics, synthetic breathing mixtures, and welding.

U.S. 287, U.S. 87—Dumas.—The Phillips Petroleum Co. extracts helium and natural gas liquids at a plant 4 miles southwest of the city on FM 722 (map location 133). El Paso Natural Gas Co. also operates a natural gas liquid extraction and compressor station on the south side of the Phillips plant. Potash chemicals and fertilizer are produced at the Potash Co. of America plant about 6 miles northeast of the city east of U.S. 287 on Tex. 119 (map location 134).

133

134

Diamond Shamrock Corp.'s 48,300-barrel-per-day crude oil refinery is about 10 miles northeast of Dumas on Tex. 119 (map location 135). About 2 miles north of the Shamrock refinery, the Continental Carbon Co. produces carbon black at its Sunray furnace-type plant. About 3 miles south of Sunray on Tex. 119 is Northern Natural Gas Co.'s Sunray compressor station. The Panhandle Eastern Sunray gas compressor station is just east of Diamond Shamrock's oil refinery. Because of the flat treeless terrain, these mineral processing facilities can be seen at a distance while traveling north or south of Dumas on U.S. 287.

135

U.S. 287, FM 281—Etter.—The Phillips Petroleum Co. produces liquid and pelletized ammonium nitrate fertilizer at plants north and east of the city (map location 136).

136

Tex. 136.—The Phillips Petroleum Co. recovers helium and natural gas liquids from natural gas at a plant near the Texas-Oklahoma border about 18 miles north of Gruver (map location 137). This plant employs the same freezing process to recover helium as described at the Bureau of Mines Exell plant.

137

SOUTHEASTERN TEXAS

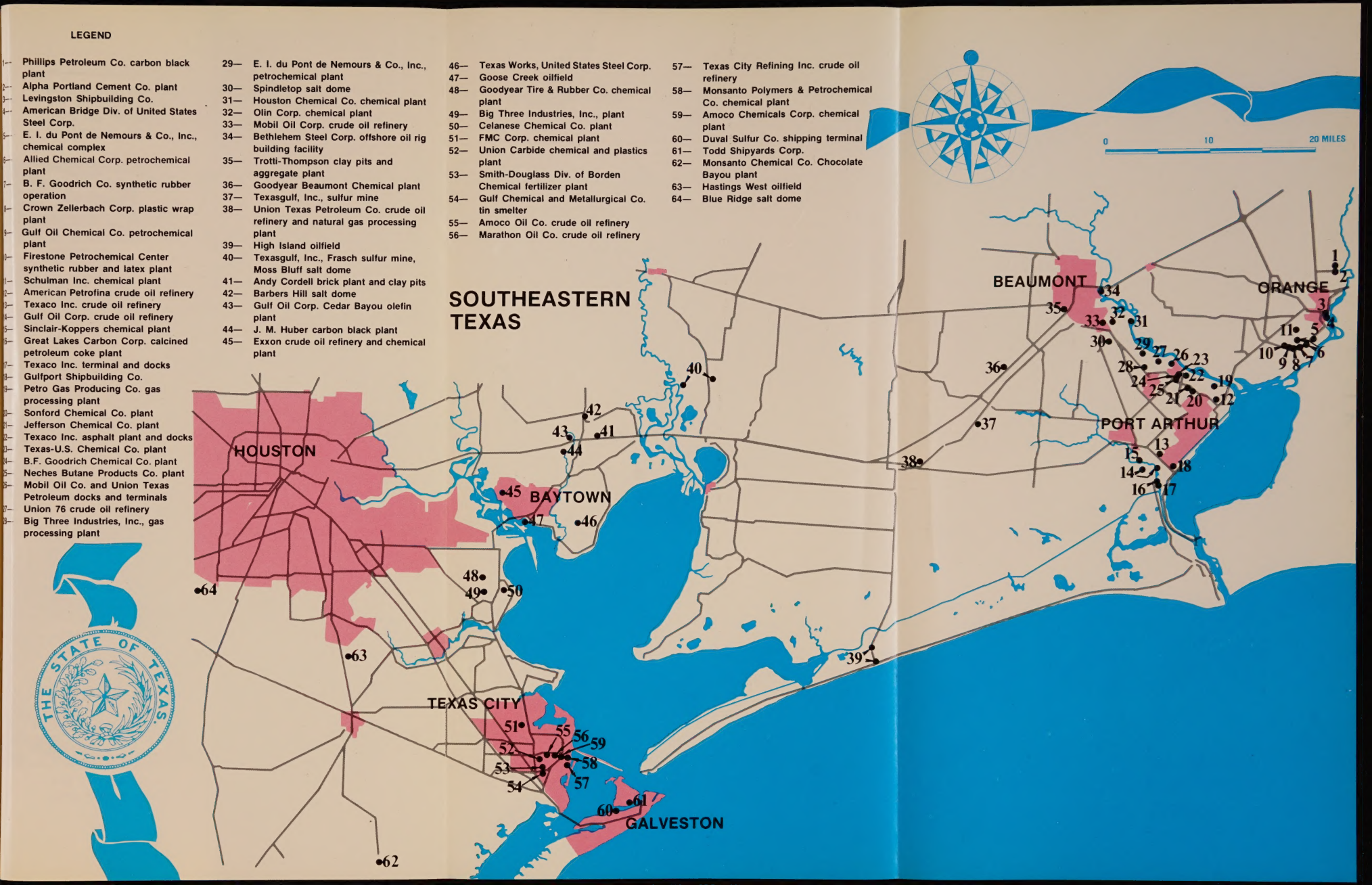
Orange—Port Arthur—Beaumont.—These cities are the cornerstones of a billion-dollar mineral producing and refining complex that is known as the "Golden

Triangle." Locations of selected mineral producing, refining, and related operations in the southeast part of the State are shown on the index map. As you enter Texas from Louisiana on Interstate 10, a variety of alternate routes are available that will take you within viewing distance of these operations and facilities.

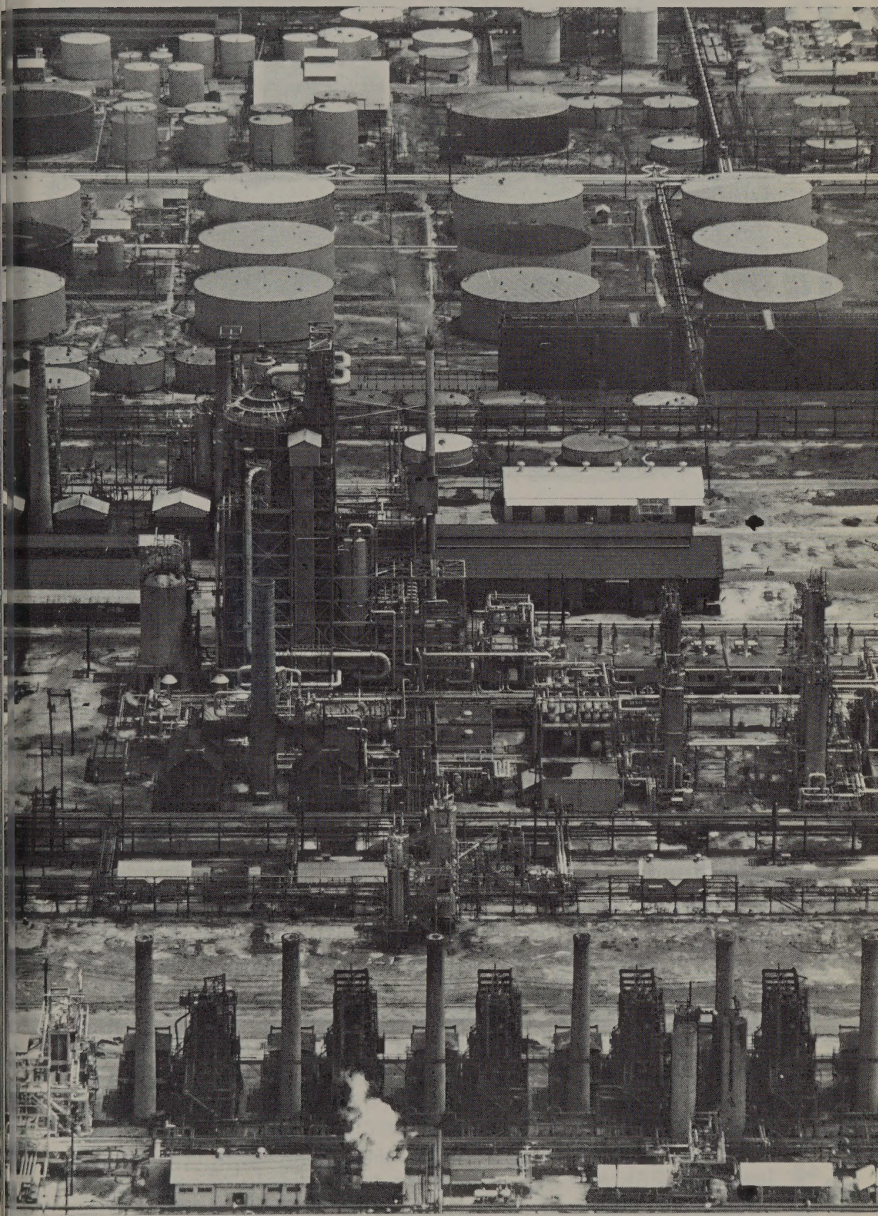
A short loop north of Orange on Tex. 87 and east on FM 1130 and FM 736 will take the traveler past the Phillips Petroleum Co.'s carbon black plant (map location 1) and Alpha Portland Cement Co.'s plant. (map location 2) Liquid hydrocarbons are used to produce carbon black for the rubber industry at this furnace-type plant. Oyster shells dredged from shallow bays and clay from open pit mines in Orange and Jasper Counties are used to manufacture portland and masonry cement. By taking Simmons Drive (Business U.S. 90) just west of the Sabine River Bridge and proceeding south to Green Street and west to FM 1006 you will pass within viewing distance of the U.S. Naval Station, Texas Group Atlantic Reserve Fleet, Levingston Shipbuilding Co. (map location 3), builders and repairers of "jack-up" drilling rigs, semi-submersible drilling ships, drilling barges, drilling tenders, pipe laying derricks, tugs and barges; and American Bridge Div. of U.S. Steel Corp. (map location 4), a fabricator of oil storage tanks, process vessels for petroleum refineries and chemical plants and large-diameter line pipe for oil and gas transmission.

Farther south on FM 1006 (Chemical Row) is the E. I. du Pont de Nemours & Co., Inc., (map location 5) a producer of nylon salts, methanol, adipic acid, ethylene, polyethylene, plastics, and other chemical intermediates; Allied Chemical Corp., a producer of ethylene glycol, ethylene oxide and ethylene amines, and high and low-density-type polyethylene, (map location 6); B.F. Goodrich Co., a manufacturer of ethylene and propylene—and diene-type synthetic rubber, (map location 7); Crown Zellerbach Corp., a maker of polyethylene plastic wrap film, (map location 8); Gulf Oil Chemical Co., a producer of polyethylene, (map location 9); Firestone Petrochemical Center, one of only four synthetic rubber and latex plants owned and operated worldwide by the Firestone Tire & Rubber Co. (map location 10). The Orange facility produces butadiene monomer, one of the basic ingredients in synthetic rubber, and three types of synthetic rubber, Diene, Stereon, and Duradene. Duradene is used primarily in tires while Diene and Stereon are primarily used in the plastics industry as reinforcing materials. North of FM 1006 is Schulman Inc., a custom producer of pigments and carbon black in polyethylenes. (map location 11).

Turning south at the intersection of Tex 87 through


LEGEND
1— Phillips Petroleum Co. carbon black plant
2— Alpha Portland Cement Co. plant
3— Levingston Shipbuilding Co.
4— American Bridge Div. of United States Steel Corp.
5— E. I. du Pont de Nemours & Co., Inc., chemical complex
6— Allied Chemical Corp. petrochemical plant
7— B. F. Goodrich Co. synthetic rubber operation
8— Crown Zellerbach Corp. plastic wrap plant
9— Gulf Oil Chemical Co. petrochemical plant
10— Firestone Petrochemical Center synthetic rubber and latex plant
11— Schulman Inc. chemical plant
12— American Petrofina crude oil refinery
13— Texaco Inc. crude oil refinery
14— Gulf Oil Corp. crude oil refinery
15— Sinclair-Koppers chemical plant
16— Great Lakes Carbon Corp. calcined petroleum coke plant
17— Texaco Inc. terminal and docks
18— Gulfport Shipbuilding Co.
19— Petro Gas Producing Co. gas processing plant
20— Sonford Chemical Co. plant
21— Jefferson Chemical Co. plant
22— Texaco Inc. asphalt plant and docks
23— Texas-U.S. Chemical Co. plant
24— B.F. Goodrich Chemical Co. plant
25— Neches Butane Products Co. plant
26— Mobil Oil Co. and Union Texas Petroleum docks and terminals
27— Union 76 crude oil refinery
28— Big Three Industries, Inc., gas processing plant
29— E. I. du Pont de Nemours & Co., Inc., petrochemical plant
30— Spindletop salt dome
31— Houston Chemical Co. chemical plant
32— Olin Corp. chemical plant
33— Mobil Oil Corp. crude oil refinery
34— Bethlehem Steel Corp. offshore oil rig building facility
35— Trotti-Thompson clay pits and aggregate plant
36— Goodyear Beaumont Chemical plant
37— Texasgulf, Inc., sulfur mine
38— Union Texas Petroleum Co. crude oil refinery and natural gas processing plant
39— High Island oilfield
40— Texasgulf, Inc., Frasch sulfur mine, Moss Bluff salt dome
41— Andy Cordell brick plant and clay pits
42— Barbers Hill salt dome
43— Gulf Oil Corp. Cedar Bayou olefin plant
44— J. M. Huber carbon black plant
45— Exxon crude oil refinery and chemical plant
46— Texas Works, United States Steel Corp.
47— Goose Creek oilfield
48— Goodyear Tire & Rubber Co. chemical plant
49— Big Three Industries, Inc., plant
50— Celanese Chemical Co. plant
51— FMC Corp. chemical plant
52— Union Carbide chemical and plastics plant
53— Smith-Douglass Div. of Borden Chemical fertilizer plant
54— Gulf Chemical and Metallurgical Co. tin smelter
55— Amoco Oil Co. crude oil refinery
56— Marathon Oil Co. crude oil refinery
57— Texas City Refining Inc. crude oil refinery
58— Monsanto Polymers & Petrochemical Co. chemical plant
59— Amoco Chemicals Corp. chemical plant
60— Duval Sulfur Co. shipping terminal
61— Todd Shipyards Corp.
62— Monsanto Chemical Co. Chocolate Bayou plant
63— Hastings West oilfield
64— Blue Ridge salt dome
SOUTHEASTERN TEXAS
0 10 20 MILES
BEAUMONT
ORANGE
PORT ARTHUR
HOUSTON
BAYTOWN
TEXAS CITY
GALVESTON
THE STATE OF TEXAS

Bridge City, the traveler will get a panoramic view of the surrounding flat terrain and industrial facilities from the Rainbow Bridge, which arches high above the Neches River. At the junction of Tex. 366 and Tex.

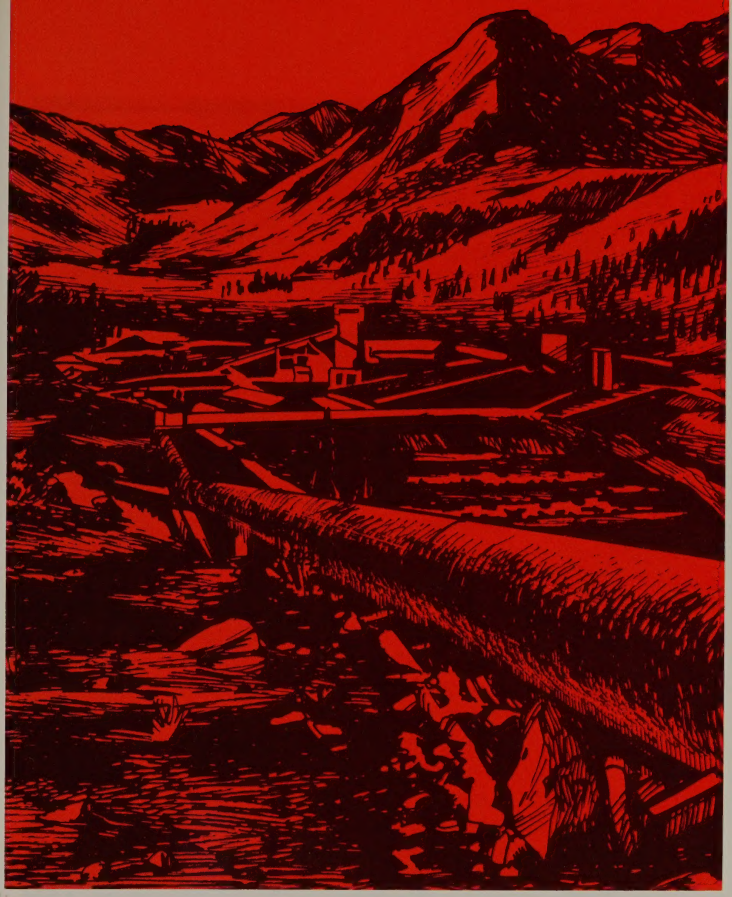


Gulf Oil Corp. crude oil refinery, Port Arthur, Tex. (Courtesy of Texas Highway Department.)

12 87 (Gulfway Drive) is American Petrofina's 84,000-barrel-per-day crude oil refinery, (map location 12). The refinery produces gasoline, kerosine, and fuel oils. Continuing south on Business Tex. 87 to the southern edge of Port Arthur, the traveler will drive
13 through one of the Nation's largest refining complexes owned by Texaco, Inc. (map location 13) and Gulf Oil Corp. (map location 14). The Texaco, Inc., and Gulf
14 Oil Corp. refineries have daily crude oil processing capacities of 406,000 and 312,000 barrels per day, respectively. Combined these two refineries represent one out of every 20 barrels of refining capacity in the United States. The Texaco refinery is also one of the World's largest grease manufacturer with an output of over 12 million pounds per month. East of the Gulf
15 refinery on FM 823 is the Sinclair-Koppers chemical plant, (map location 15), a producer of polythylene and ethylbenzene. South of the Gulf refinery on Tex. 87 is the Jones Laughlin Steel Corp. and U.S. Steel Corp. oil and chemical container manufacturing plants, and
16 Great Lakes Carbon Corp., a producer of calcined petroleum coke, (map location 16). Petroleum coke is a high-carbon residue from the crude oil refining process.

At the junction of Spur 214 and Tex. 87, the traveler can make a quick trip over the Gulfgate Bridge via the Texaco-Gulf highway (West Levee Road) to
17 see the Texaco, Inc., terminal and docks (map location 17); the sprawling Gulfport Shipbuilding Co., the
18 builder of some or the world's largest oceangoing barges and offshore oil rigs, (map location 18); and the port of Port Arthur. Returning to the American Pe-
12 trofina refinery on Tex. 366 (map location 12) and proceeding north is the Petro Gas Producing Co., a pro-
19 ducer of propane, butane, ethylene, and proplylene (map location 19); Sonford Chemical Co., a manufac-
20 turer of hydrogen chloride, calcium chloride, pentachlorophenol, and toxaphene (map location 20); and Jefferson Chemical Co., a producer of over 30 petrochemicals including sodium hydroxide, chlorine, jet
21 juel additives, ethylene glycol, and formulated antifreeze glycols (map location 21).

South of the city of Port Neches on Tex. 366 is the
22 Texaco, Inc., asphalt plant and docks (map location 22). Texaco produces asphalt and a variety of surfac-
23 ing materials at this plant. Texas-U.S. Chemical Co. (map location 23), B.F. Goodrich Chemical Co. (map
24 location 24), and Neches Butane Products Co. (map location 25), are all producers of a variety of synthetic
25 rubber and petrochemicals. North of Port Neches the traveler will pass Mobil Oil Co. and Union Texas Petroleum's docks and terminals that provide storage
26 and shipping facilities for petroleum and petrochemical products (map location 26); the Union 76 127,000-



barrel-per-day refinery makes motor gasoline, diesel fuels, heating oils, residual fuel oils, and petrochemical feedstocks (map location 27). North of the city of Nederland on Tex. 347 is the Big Three Industries, Inc., a producer of liquid argon, nitrogen, and oxygen gases (map location 28); and E. I. du Pont de Nemours & Co., Inc., a manufacturer of polyethylene rubber, calcium salt, aniline, acrylonitrile, methanol, tetraethyllead ammonia, and other petrochemicals (map location 29).

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On the south edge of Beaumont near the junction of Tex. 347 and U.S. 69, 96, and 287 is the world-famous Spindletop salt dome (map location 30). It was here on January 10, 1901, that the liquid fuel age began when the Lucas wildcat well blew in producing a heretofore unheard of oil flow rate of about 100,000 barrels of oil per day. Production was from the porous limestone cap rock overlying the salt plug at a depth of about 1,000 feet. Pieces of elemental sulfur blown from the gusher with the oil and gas gave evidence that the limestone cap rock also contained sulfur. The Spindletop oilfield has produced over 150 million barrels of oil; however, most of the production has been from wells drilled to deeper formations

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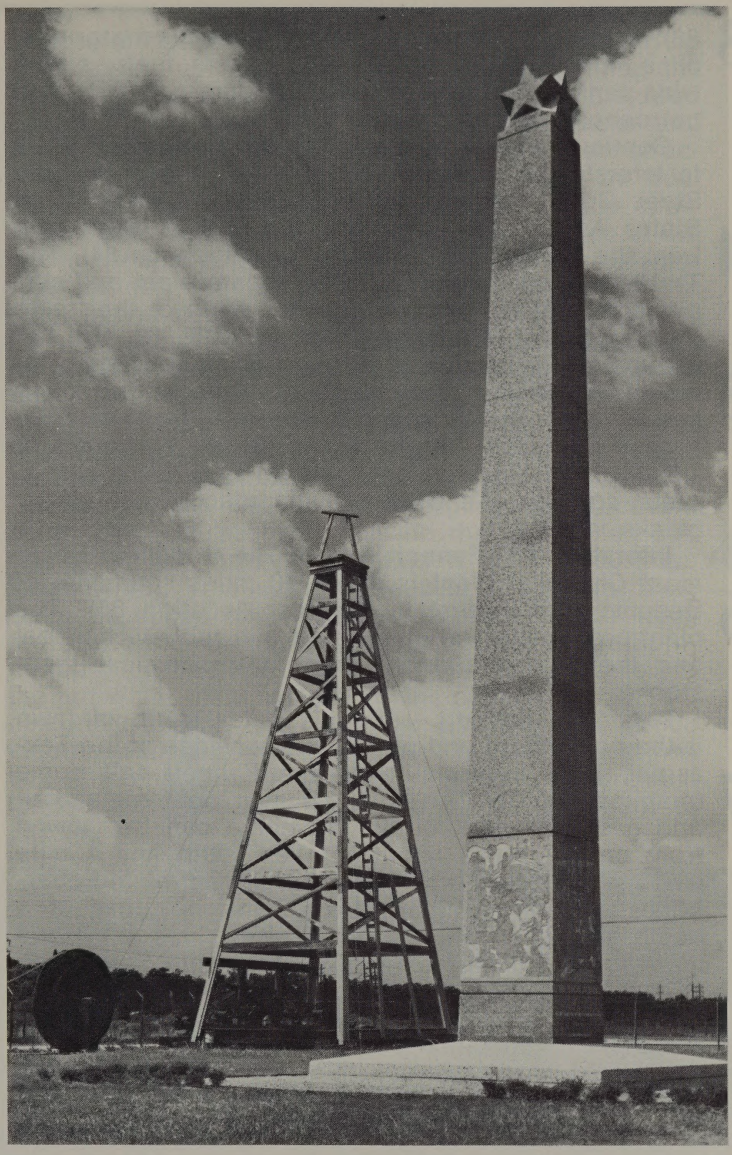
around the outer edge of the salt plug. On Spindletop Avenue is the Lucas Gusher Monument commemorating the discovery of the Spindletop field. This monument has been designated as a National Historical Site by the U.S. Department of the Interior. Adjacent to this monument is an outdoor museum containing a replica of a wooden derrick and drilling and production equipment that were used to develop this oilfield.

In 1952, after most of the shallow cap rock oil wells had "run dry," Texasgulf, Inc., began mining sulfur from the limestone cap rock over the Spindletop salt dome. Sulfur, or brimstone, is mined by the Frasch process that consists of injecting superheated water (about 300° F) into the sulfur-bearing limestone cap rock. Frasch mining employs the same well bore for both hot water injection and sulfur recovery. This is accomplished by installing pipes concentrically so that the hot water can be injected between the outer and inner pipes into the top of the sulfur-bearing formation. The melted sulfur, which liquifies at about 240° F, flows to the bottom of the borehole where it is air lifted to the surface through the inner pipe. The produced sulfur is pumped in liquid form through steamheated insulated pipes to a storage area and shipping terminal on the ship channel across Tex. 347 from the company's powerplant. You will note that the steamheated pipes have loops or expansion bends to compensate for the wide variations in temperature.

Millions of tons of yellow sulfur are stockpiled at the shipping terminal in solid blocks that reach heights of almost 100 feet and lengths up to 0.5 mile. These blocks have been formed by the successive pourings of hot liquid sulfur that has cooled and solidified. The insulated tanks near the solid yellow blocks contain sulfur that is maintained in a molten state. Sulfur is shipped from this terminal in both molten and solid form to markets in the United States and other countries. The uses of sulfur are so numerous that sulfur consumption is a basic indicator of industrial development. One of its principal uses, however, is in the production of fertilizers such as ammonium sulfate.

On the east edge of the dome, the United Salt Co.'s Texas Brine Div. produces salt by solution mining from a depth of over 5,000 feet although the top of the salt plug at Spindletop is only 1,200 feet below the surface. This is the deepest solution mine in the State. In solution mining, freshwater is injected through a cased well bore to dissolve the rock salt, and the resulting brine is pumped to the surface through a string of tubing installed inside the cased borehole. The produced brine is used for servicing oil and gas wells and as feedstock for several chemical plants in the Golden Triangle area.



Spindletop monument and outdoor oil museum, Beaumont, Tex. (Courtesy Lucas Gusher Monument Association.)

North of Texasgulf's sulfur shipping terminal near the ship channel is the Houston Chemical Co., Div. of PPG Industries (map location 31). This chemical plant produces diethyl glycol, ethylene oxide, tetraethyl-lead, antifreeze and anti-icing agents. The Olin Corp. produces sulfuric acid and sulfur chemicals at a plant near the Houston Chemical Co. (map location 32). The Mobil Oil Corp. 335,000-barrel-per-day refinery is on Spur 380 in the city of Beaumont (map location

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33 33). This large integrated refinery produces motor gasoline, fuel oils, lubricating oils, diesel fuels, and a wide range of other refined petroleum products and petrochemical feedstocks.

Continuing north on Spur 380 and Business U.S. 90 to Interstate 10, the traveler can view the Bethlehem Steel Corp. offshore oil rig building facility, Gulf
34 States Asphalt Co., Inc., and the Port of Beaumont from the Neches River bridge (map location 34). The Trotti-Thompson lightweight aggregate plant and clay pits are on Washington Boulevard north of the traffic interchange of Interstate 10 and U.S. 96, 69, and 287
35 bypass on the southeast edge of Beaumont (map location 35). Clay mined from the Beaumont Formation has the property to expand or "bloat" when heated in a gas-fired rotary kiln to a temperature in excess of 1,500° F. This lightweight material is used as a concrete aggregate and in the manufacture of cinder blocks.

Interstate 10—Fannett Area.—The Goodyear Beau-
36 mont Chemical plant is about 10 miles southeast of Beaumont on Interstate 10 (map location 36). The plant produces a variety of synthetic rubber chemical and thermoplastic resins from petrochemical feedstocks.

Tex. 124—Fannett.—About 2 miles south of town is the powerplant and production facilities of the Tex-
37 asgulf, Inc., sulfur mine on the Fannett salt dome (map location 37). The sulfur wells on the dome and oil and gas wells that circle the dome can be viewed from county roads about 2 miles south and 1 mile east of the powerplant. Texasgulf began mining operations on this dome in 1958. Sulfur is mined at a depth of about 1,300 feet by the same Frasch method as described at the company's Beaumont Spindletop mine.

Tex. 124, Tex. 73—Winnie.—Between Winnie and Hamshire is the Union Texas Petroleum Div. of Allied
38 Chemical Corp. 9,400-barrel-per-day crude oil refinery and natural gas processing plant (map location 38). The company produces a variety of fuels including butane, propane, and diesel fuels.

39 **Tex 124—High Island.**—The High Island oilfield (map location 39) has produced over 130 million barrels since it was discovered in 1922. Note, that oil wells and other production equipment form a circle, or halo, around the town of High Island, which sits atop a mound-shaped hill. High Island is not actually an island but is the surface manifestation of a massive piercement salt plug that has protruded to within 1,300 feet of the surface. Early settlers called this mound-shaped hill an island because it rises abruptly over 100 feet above the surrounding flat marshlands. The oil wells in the High Island field are completed in

structural "traps" that were formed by the tilting-up or dragging-up of the ruptured formations along the flanks of the salt conduit as it expanded and flowed upward. Note, also, that many pumping jacks and other production equipment are on elevated structures to protect against potential damage by tidal waves during hurricanes. In the 1960's, Amoco operated a Frasch sulfur mine in the northeast area of the dome. At the junction of Tex. 87 and Tex. 124, the traveler can see oil well "Christmas trees" on the High Island beach and out into the Gulf of Mexico. Pilings have been driven around the nearshore wells to protect them from accidental damage from boats and hurricanes. Wells farther out are generally completed on platforms that stand 20 feet or more above the water. When visibility is good, it is possible to see platforms that are located about 10 miles offshore.

Interstate 10, FM 563.—Texasgulf, Inc., recovers sulfur by the Frasch process on the Moss Bluff salt dome 4 miles north of Interstate 10 on FM 563 (map location 40). This sulfur mine was opened in 1948. Sulfur is mined from a depth of about 900 to 1,000 feet using the same method as described at the Spindletop sulfur mine at Beaumont. The sulfur wells are the hot water plant, which has the capacity of about 4 million gallons of hot water per day, are on FM 563 Liquid sulfur is pumped in heated insulated pipelines to a shipping terminal on the Trinity River where it is loaded into "thermos-type" barges for shipment to market.

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Sulfur storage terminal at the Texasgulf Spindletop sulfur mine. Liquid sulfur from the mine is pumped through the insulated pipes onto the tops of the sulfur blocks where it cools and adds another tier to the solid sulfur block.

41 **Interstate 10.**—The Andy Cordell brick plant is 2 miles east of Mont Belvieu on the north access road of Interstate 10 (map location 41). Building bricks are manufactured from clays of the Beaumont Formation (Cenozoic). The clays are mined from open pits near the plant.

42 **Interstate 10, Tex. 146—Mont Belvieu.**—The town of Mont Belvieu sits atop the Barbers Hill salt dome (map location 42) completely ringed by derricks, pumping jacks, oil storage tanks, and natural gasoline plants in the Barbers Hill oilfield. Since its discovery in 1916, the field has produced over 120 million barrels of oil. Production is from the Frio Formation at depths between 5,000 and 10,000 feet. A striking contrast in oilfield equipment can be seen in this field because new wells have recently been completed adjacent to wells that are still using some of the ancient equipment installed about 50 years ago. On the west side of the dome, plants operated by the Warren Petroleum Co. and Cities Service Oil Co. extract natural

Sulfur production wells on Spindletop salt dome.

gas liquids (butane, propane, and natural gasoline) from casinghead gas produced from the Barbers Hill field and other nearby oil and gas fields. The world's largest underground storage facilities for liquified petroleum gases are in this salt dome. The underground storage caverns, called "jugs" by oilmen, were created by drilling a well into the salt to the desired cavity depth and then injecting fresh water through the well bore to dissolve the salt. The desired size and shape of the cavity can be attained by varying the freshwater injection point, the input rate, and the volume of water injected. Individual caverns range widely in both shape and volume. Some jugs are more or less spherical, whereas others are cigar shaped with a diameter of a few hundred feet and a height of thousands of feet. The storage capacity of the jugs range from a few hundred thousand gallons to over 500 million gallons. Each surface wellhead assembly or "Christmas tree" is connected by pipes to one jug, which is completely enclosed in the rock salt. Depth to the top of the salt at Mont Belvieu is about 1,300 feet. The massive "Christmas trees", gas dryers, pumping stations, and other surface facilities can be viewed from Tex. 146 and Loop 207 in the town. The famous "Little Inch" pipeline of World War II fame and other transcontinental pipelines originate on this dome.

On the southeast side of the dome, Diamond Shamrock Co. produces salt by solution mining. The produced brine is used to manufacture industrial chemicals at the company's plants on the Houston ship channel.

Interstate 10—Baytown and Vicinity.—North of Baytown and about 2 miles east of Mont Belvieu on Interstate 10 is the Gulf Oil Corp. Cedar Bayou olefin plant (map location 43). This plant produces polyethylene pellets, low-density polyethylene resins, aromatic distillate, ethylene, normal alpha olefin and propylene. The J. M. Huber Corp. furnace-type carbon black plant is about a mile south of Interstate 10 and the Gulf olefin plant on Needlepoint Road (map location 44). Carbon black from this plant is used to produce high-speed news ink. Exxon's 400,000-barrel-per-day-oil refinery and chemical plant is on the east side of Baytown adjacent to Scott Bay and the Houston ship channel (map location 45). This refinery, one of the Nation's largest, produces motor gasoline, aviation gasoline, plasticizers, drilling fluid additives, aromatic concentrate, distillate and residual fuel oils, aliphatic solvents and light hydrocarbons, propane, propane-butane mixtures, and lubricants. The chemical plant produces a variety of petrochemicals including aromatic concentrate, benzene, propylene, paraffins, and isoprene-type rubber.

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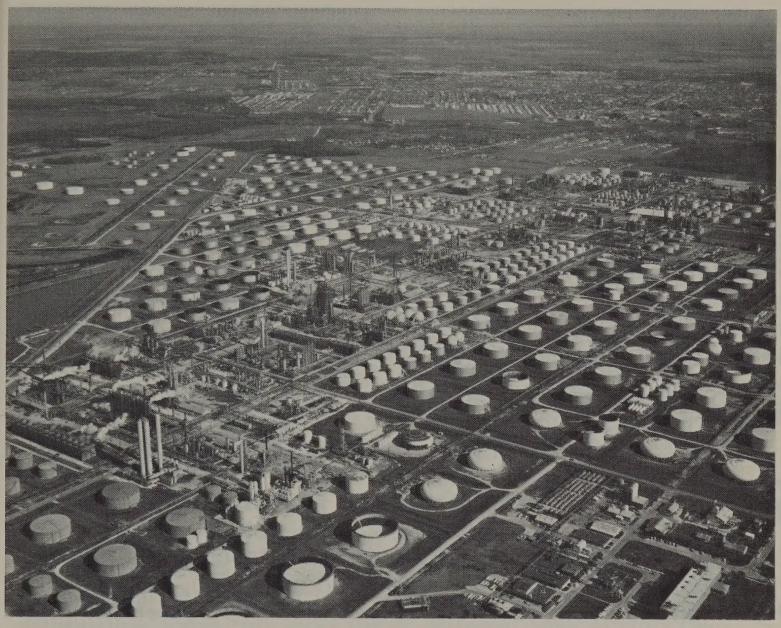
47 On Tex. 146 in the south edge of Baytown is the Goose Creek oilfield that was discovered in 1906 (map location 47). The field has produced over 130 million barrels of oil from the Frio Formation at an average depth of about 4,600 feet. Note the well density in this field and the fact that many wells are completed on platforms out in the bay. These wells were the State's first offshore completions in the gulf coast area. From this humble beginning, offshore drilling has progressed to the middle of Galveston Bay (Red Fish Reef field) and to more than 100 miles offshore in the Gulf of Mexico. Most wells in the Goose Creek field were drilled with wooden derricks, which were later replaced with steel derricks to facilitate workovers such as replacement or repairs of rods, tubing, and down-hole pumps. The close well spacing and steel derricks represent a passing era because the State of Texas now frowns on close well spacing, and the cost and upkeep of steel derricks makes them economically unattractive. Today most wells are serviced with truck-mounted jackknife derricks or gin poles.

Goose Creek oilfield south of Baytown on Tex. 146.



Exxon refinery and petrochemical complex, Baytown, Tex. (Courtesy of Exxon.)

About 6 miles east of Baytown on FM 1405 is the Texas Works of the U.S. Steel Corp. (map location 46). This modern complex, the first completely new facility built by U.S. Steel Corp. in the last two decades, has an annual capacity of more than 1 million tons of high-strength alloy and carbon steel plate. This plant also features an 89-inch continuous slab caster. **46**

Tex. 146—La Porte.—South of the city is the Goodyear Tire & Rubber Co. chemical plant that produces a variety of synthetic rubber (map location 48); and Liquid Air, Inc., facility that extracts and liquifies argon, nitrogen, and oxygen from the atmosphere. West of Tex. 146 is the Big Three Industries, Inc. (map location 49), which extracts argon, nitrogen, and oxygen from the atmopshere, and the Celanese Chemical Co., a producer of acetaldehyde, acetic acid, ethylene glycol, ethylene oxide, methanol, and vinyl acetate (map location 50). **48** **49** **50**

Tex. 146—Seabrook—Texas City.—At Seabrook, the traveler can take a short diversionary loop to the Johnson Space Center via NASA No. I. Returning to Tex. 146 and proceeding south to Texas City, the motorist will pass the 2,230-megawatt steam electric generation plant of the Houston Power & Light Co. and the FMC Corp. (map location 51). The FMC Corp. produces acetic acid, allyl alcohol, glycerin, and epoxidized soybean oil. In a large industrial area bounded by highways 146, 1765, 519, and 197 on the south edge of Texas City is the Union Carbide chemi- **51**

52 cal and plastics plant (map location 52) that produces 24 different petrochemicals including acetone, low-density polyethylene, paraffins, and biodegradable detergents; Smith-Douglass Div. of Borden Chemical, manufacturers of nitrogenous fertilizers and pelleted monoammonium phosphate fertilizers (map location 53); the Gulf Chemical and Metallurgical Co. (map location 54) produces refined tin from Bolivian ores and from scrap. This is the only tin smelter in the United States. Also in the area are the Amoco Oil Co.'s 333,000-barrel (map location 55), Marathon Oil Co.'s 64,000-barrel (map location 56), and Texas City Refining Inc. (map location 57) 74,500-barrel-per-day crude oil refineries and tank farms. These refineries produce motor gasoline, diesel fuels, fuel oils, jet fuel, cleaning solvent, and liquified refinery gases. Adjacent to the refineries is the Monsanto Polymers & Petrochemical Co. (map location 58), a producer of aluminum chloride, high-density polyethylene, styrene monomer, lactic acid, and a variety of other petrochemicals; and Amoco Chemicals Corp. (map location 59), a maker of methanol, styrene resins, petroleum polymer resins, aromatic solvents, methyl mercaptan, and secondary vinyl plasticizers.

Galveston.—Duval Sulfur Co.'s sulfur shipping terminal (map location 60) is on Industrial Boulevard and can be viewed from adjacent public streets and from the bridge that crosses the Intracoastal Canal on the way to Pelican Island. The long rows of railroad tank cars at the terminal are parts of unit trains that haul this sulfur from the company's Orla mine some 900 rail-miles away in west Texas. On Pelican Island is the Todd Shipyards Corp. (map location 61) that builds and repairs large floating drilling rigs, drill ships, and auxiliary vessels that are used in exploration and development of offshore oil and gas fields.

Tex. 194—Alvin.—About 15 miles south of Alvin at the end of Tex. 194 on Chocolate Bay is the Monsanto Chemical Co. Chocolate Bayou plant (map location 62). This large plant produces about 25 petrochemicals that include acetone, phenol, aromatic solvents, benzene, toluene, ethane, ethylene, and propylene.

Tex. 35—Pearland—Alvin.—Midway between these two cities about 15 miles south of Houston is the Hastings West oilfield (map location 63) and natural gas processing plant. In addition to being one of the Nation's largest oil producers, this field is equipped with some of the most modern and automated production equipment. The field has produced over 200 million barrels of oil since it was discovered in 1958. Production is from the Frio Formation at a depth of about 6,200 feet. Pumping jacks are scarce in this field because the oil is produced by natural flow or by gas

lift. The produced oil is separated from associated gas and water in separators and/or heater treaters before it is measured by LACT (Lease Automated Custody Transfer) units. The pipeline-quality crude oil then flows directly into two large storage tanks in the northeast portion of the field where the oil is metered again before it is pumped directly to the oil refiners. Amoco, the principal producer in the field, operates a natural gas processing plant adjacent to the highway. Water produced with the crude oil is reinjected into subsurface formations.

U.S. 59, U.S. 90A, FM 2234—Houston—Missouri City—Blue Ridge.—About halfway between Tex. 288 and U.S. 59 and U.S. 90A is the Blue Ridge salt dome (map location 64). United Salt Corp. mines salt by the solution method to produce evaporated salt for table and other refined salt usage. **64**

HOUSTON SHIP CHANNEL

A 50-mile drive along the Houston Ship Channel to Galveston takes the traveler through and by one of the largest aggregations of petrochemical plants, oil refineries, steel, tin, and other mineral processing facilities in the world. The inset map for the Houston Ship Channel will assist the motorist in locating selected mineral producing and processing facilities between the turn basin in South Houston and the Baytown tunnel on Tex. 146. It should be noted that only those facilities that can be observed from public streets and highways are identified.

Visitors can view the turn basin of the Port of Houston from an observation platform at the end of the ship channel off Clinton Drive. An "insider" view of the Port of Houston facilities can be had by boarding the port authority's inspection boat for a ride down the channel. Reservations for free passage on the inspection boat can be obtained by writing the Port of Houston, 1519 Capital Avenue, P.O. Box 2562, Houston, Tex. 77001, telephone number (713) 225-0671. The inspection tours leave from the Sam Houston Boat Dock, off Clinton Drive, at 10 a.m. and 2 p.m. Reservations are necessary to insure passage.

Leaving the Sam Houston boat dock (map location 1) or port observation area at the turn basin (map location 2), the traveler can tour either the north or south sides of the ship channel or choose a combination of north and south routes. **1** **2**

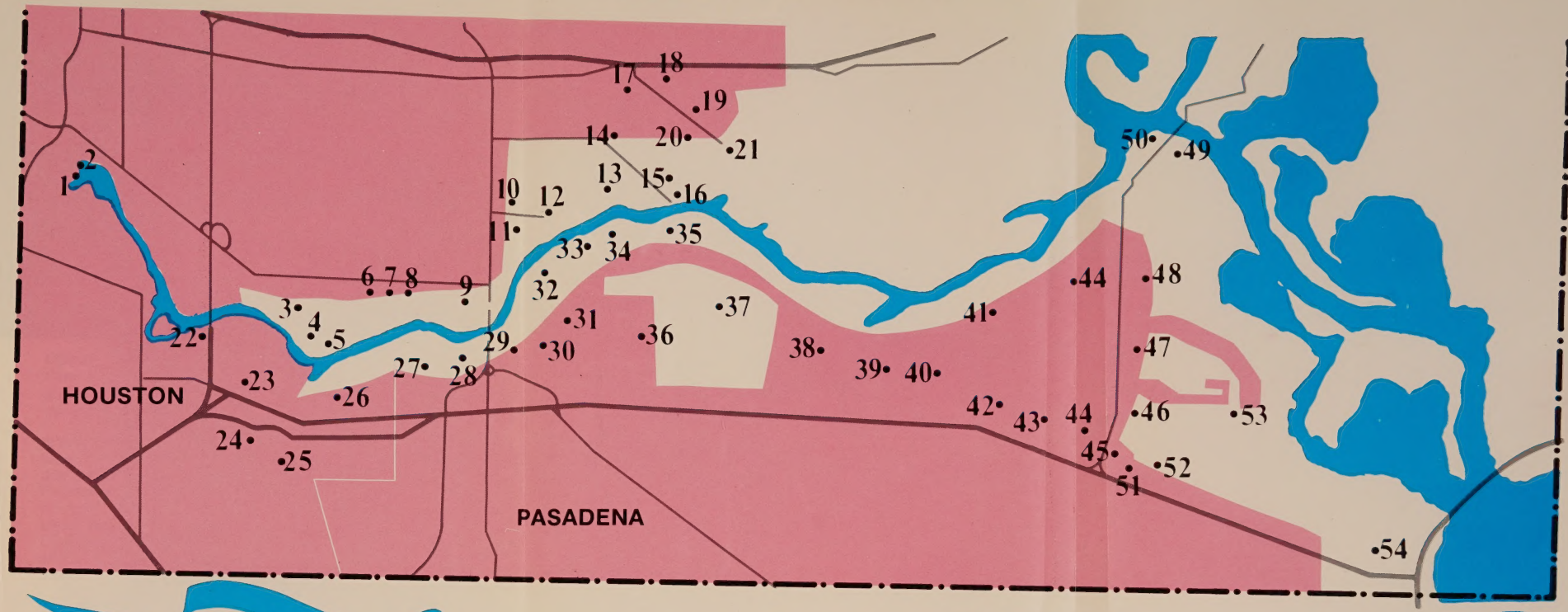
Choosing the north route the motorist should drive east on Clinton Drive by the Ideal Cement Co. Houston Div. plant (map location 3). This plant produces portland, masonry, and white cement from oyster shells dredged in shallow gulf coast bays and Beaumont Clay (Cenozoic) obtained from open pits near League City in Galveston County. Continuing east, one can see the American Plant Food Corp. (map lo- **3**

cation 4), which manufactures sulfuric acid, ammonium sulfate and superphosphate fertilizers; United States Gypsum Co. (map location 5), a large producer of wallboard from crude gypsum; the Chemical Exchange Processing Co., Inc. (map location 6), a manufacturer of petrochemicals, gasoline blendstocks, and fuel oil; the Velsicol Chemical Corp. (map location 7), a producer of phosphate-based insecticides and hot-melt adhesives; and the petroleum products storage terminals of General American Transportation Corp. (map location 8) and Texaco, Inc. (map location 9). This brings the traveler to FM 526 at the traffic circle and access to the Washburn Tunnel under the ship channel.

Proceeding north on FM 526, one can see the Gulf Oil Corp. (map location 10), Warren Petroleum Corp. (map location 11), and Amerada Hess petroleum storage terminals (map location 12). Turn east on Industrial Road to the sprawling Sheffield Works of Armco Steel Corp. (map location 13). Iron ores and scrap are processed into carbon and alloy steel plates and bars, reinforcing bars, semi-finished shapes, structural shapes, wide flange structural beams, steel wire, and wire products. Also at this steel mill are coke ovens and a direct iron ore reduction plant for converting iron ore into suitable feedstocks for electric furnaces. In the central area of the steel mill you can see the large blast furnace, the direct ore reduction unit, and the coke ovens. On the east side of the plant are piles of metallurgical coal and iron ore pellets that have been unloaded from barges and ships. Opposite Armco is the Tenn-Tex Alloy Corp. (map location 14), a producer of ferroalloys including ferromanganese and siliconmanganese. The street ends at Brown and Root Inc. (map location 15) and Todd Shipyards Corp. (map location 16) on the ship channel. At this point you can get a closeup view of the large platforms and other petroleum production equipment that are constructed here. The production platforms are floated down the ship channel out into the Gulf of Mexico where they will be "sunk" or erected to form an above-water operating base for several wells that will be directionally drilled from each platform. You may count the number of wells that a platform can accommodate by noting the number of well guides (doughnut holes) inside of the derrick superstructure.

Returning to Market Street via Sheffield Road or FM 526 and proceeding east to the access road at Interstate 10 and then south on Haden Road will bring the traveler past the Stauffer Chemical Co. (map location 17), which produces hydrofluoric acid and aluminum fluoride; Reichold Chemicals, Inc. (map location 18), producers of alkyd resins, epoxy resins, polyester

HOUSTON SHIP CHANNEL



LEGEND

1— Sam Huston boat dock
2— Port of Houston observation area
3— Ideal Cement Co. plant
4— American Plant Food Corp. chemical fertilizer plant
5— United States Gypsum Co. wallboard plant
6— Chemical Exchange Processing Co., Inc., chemical plant and refinery
7— Velsicol Chemical Corp. chemical plant
8— General American Transportation Corp. oil storage terminals
9— Texaco Inc. petroleum storage terminals
10— Gulf Oil Corp. storage terminal
11— Warren Petroleum Corp. storage terminal
12— Amerada Hess Corp. petroleum storage terminal
13— Sheffield Works of Armco Steel Corp.
14— Tenn-Tex Alloy Corp.
15— Brown and Root Inc.
16— Todd Shipyards Corp.
17— Stauffer Chemical Co. plant
18— Reichold Chemicals, Inc., plant
19— Merichem Co.
20— Pennwalt Corp.
21— Diamond Shamrock Chemical Co. plant
22— Lone Star Industries cement plant
23— Charter International Oil Co. crude oil refinery and tank farm
24— Goodyear Tire and Rubber Co. chemical plant
25— Petro-Tex Chemical Co. petrochemical plant
26— Atlantic Richfield Co. crude oil refinery
27— Sinclair-Koppers Chemical Co. plant
28— Champion Paper Co. paper products and lime plant
29— Crown Central Petroleum Corp. crude oil refinery
30— Premier Petrochemical Co. plant
31— General American Transportation Corp. liquid storage facility
32— Horton & Horton Inc. dock facility
33— Olin Corp. Chemical Div. chemical fertilizer plant
34— Stauffer Chemical Co. chemical fertilizer plant
35— Phillips Chemical Co. plant
36— Petroleum pipeline stations (Phillips, Colonial, and Explorer)
37— Ethyl Corp. petrochemical plant
38— Tenneco Chemicals, Inc., chemical plant
39— Shell Oil Co. crude oil refinery
40— Shell Chemical Co. petrochemical plant
41— Diamond Shamrock Chemical Co. petrochemical plant
42— Lubrizol Corp. lubricant additive plant
43— Union Carbide Corp. gas processing plant
44— Rohm & Haas Texas, Inc., petrochemical plant
45— Upjohn Co. Polymer Chemical Div. petrochemical plant
46— Texas Alkyls, Inc., chemical plant
47— Celanese Plastics Co. petrochemical plant
48— Diamond Shamrock Chemical Co. petrochemical plant
49— San Jacinto Monument and Battleground
50— Battleship Texas
51— Southwest Specialty Chemicals Inc. chemical plant
52— Air Products and Chemicals, Inc., specialty gas processing plant
53— U.S. Industrial Chemicals Co. petrochemical plant
54— E. I. du Pont de Nemours & Co., Inc., petrochemical plant

Offshore oil platform under construction at the Todd Shipyards Corp. adjacent to the Houston Ship Channel. This platform can accommodate 18 oil or gas wells that can be completed through the well guides visible in the center of the derrick.

resins, and formaldehyde; the Merichem Co. (map location 19), which produces sodium sulfhydrate, sodium sulfide, cresol, cresylic acid, and phenol; and Pennwalt Corp. (map location 20), makers of a variety of mercaptans including ethyl mercaptans that are used as an odorizer in natural gas; and finally to the Diamond Shamrock Chemical Co. (map location 21), which produces hydrochloric acid, herbicides, and fungicides.

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Facilities on the south side of the channel can be viewed by taking Loop 610 over the ship channel. The Lone Star Industries cement plant is almost under the west edge of the bridge over the ship channel (map location 22). This plant produces portland and masonry cement from oyster shells dredged from shallow gulf coast bays and Beaumont Clay (Cenozoic) mined in the Pasadena area of Harris County. Turning east on Tex. 225 or Lawndale Road, one can see the Charter International Oil Co. 70,000-barrel-per-day crude oil refinery and petroleum tank farm (map location 23). This refinery produces a full range of petroleum products including motor gasoline, jet fuel, kerosine, and benzene. South of Tex. 225 is the Goodyear Tire & Rubber Co. Houston chemical plant (map location 24). This plant produces synthetic rubber including butadiene-acrylonitrile-type rubber and butadiene-styrene-type rubber. East of the Goodyear plant is Petro-Tex Chemical Co. (map location 25), which produces butyl rubber, neoprene, motor alkylates, diisobutylene, and other petrochemicals. North

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of Tex. 225 is the Atlantic Richfield (Arco) 213,000-barrel-per-day crude oil Houston refinery (map location 26), which manufactures motor gasoline, jet fuel, kerosine, butane, ethane, propane, lubricating oils and greases, asphalt, and a variety of other refined petroleum products; Sinclair-Koppers Chemical Co. (map location 27), a producer of ethylbenzene, styrene, and ethylene; and Champion Paper Co. (map location 28), which in addition to producing paper products, manufactures lime for various industrial uses from oystershell. East of the Washburn Tunnel is the Crown Central Petroleum Corp. 100,000-barrel-per-day Pasadena oil refinery that produces motor gasoline, benzene, petroleum coke, kerosine, fuel oils, and propane (map location 29); Premier Petrochemical Co., a producer of urea, which is used as a fertilizer, animal feed, and in the synthesis of plastics, resins, and barbiturates and in medicine as a diuretic (map location 30); General American Transportation Corp.'s liquid storage facility (map location 31); and Horton & Horton Inc.'s dock facility for their shell dredging and sand and gravel operations (map location 32). Oyster shells dredged from shallow bays are an important raw material in the manufacture of lime and cement. Shell is also used for concrete aggregate and road base material. The Olin Corp. Chemical Div. (map location 33) and the Stauffer Chemical Co. (map location 34) both process phosphate rock into phosphate fertilizer and a variety of other products. The large high rectangular mounds near these plants are composed principally of white gypsum, a byproduct of the processing of the phosphate rock. The phosphate rock is from Florida and foreign countries. The Phillips Chemical Co. (map location 35) produces polyethylene resins, anhydrous ammonia, ammonium nitrate, urea solutions, and phosphoric acid. The Phillips, Colonial, and Explorer pipeline stations (map location 36) are the starting points for petroleum product lines that, in the case of the Colonial system, extends back to the Mid-Atlantic States. The Ethyl Corp. (map location 37) makes 18 different petrochemicals including chlorine, aluminum sulfate solution, linear detergent alcohols, and aluminum powder; Tenneco Chemicals, Inc. (map location 38), produces acetylene, oxygen, methanol, vinyl chloride monomer, and anhydrous ammonia; the Shell Oil Co. 294,000-barrel-per-day Deer Park refinery (map location 39) produces motor gasoline, jet fuels, lubricating oils, and a wide variety of other refined petroleum products; Shell Chemical Co. (map location 40) manufactures 31 different petrochemicals including sodium hydroxide, soil fumigants, butyl alcohols, and propylene; the Diamond Shamrock Chemical Co. Tidal Road plant (map location 41) produces hydrogen,

chlorine, hydrochloric acid, polyvinyl chloride resins, and several other petrochemicals. The Lubrizol Corp.'s Deer Park plant makes lubricant additives (map location 42); Union Carbide Corp. extracts and refines nitrogen, oxygen, and argon from the atmosphere (map location 43); and Rohm & Haas Texas, Inc. (map location 44) produces a wide range of petrochemicals that includes acetylene, carbon monoxide, hydrogen, acetone cyanohydrin, butyl acrylate, and ammonia. Turning north at Tex. 134, one can see the Upjohn Co.'s Polymer Chemical Div. (map location 45), a producer of a variety of petrochemicals some of which are used in the production of simulated wood furniture, insulation material, and urethane mattresses; the Texas Alkyls, Inc. (map location 46), manufactures about two dozen specialty chemicals including aluminum chloride and other aluminum chemicals used in the production of plastics and synthetic rubber; the Celanese Plastics Co. (map location 47) makes nylon resins and polyethylene resins; and Diamond Shamrock Chemical Co.'s Battleground plant produces polypropylene resins (map location 48). At this point, the motorist can visit the San Jacinto Monument and Battleground (map location 49). It was here that Texas won its independence from Mexico in 1836. The Battleship Texas is moored adjacent to the Houston ship channel (map location 50). Visiting hours for the monument and battleship are from 11 a.m. to 6 p.m. from May through August.

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Returning to Tex. 225 and continuing east is the Southwest Specialty Chemicals Inc. (map location 51) that compounds pigments and resins; Air Products and Chemicals, Inc. (map location 52), a producer of carbon monoxide, hydrogen, nitric oxide, acetylene, argon, krypton, neon, hydrogen chlorides and fluorides, and a number of specialty industrial gases; the U.S. Industrial Chemicals Co. (map location 53), a producer of polyethylene resins, industrial alcohol, and vinyl acetate monomer; and E. I. du Pont de Nemours & Co., Inc., Biochemicals Department (map location 54), a producer of sulfuric acid, hydrofluoric acid, formaldehyde, amines, polyvinyl alcohol, vinyl acetate, fungicides, herbicides, and insecticides. The traveler is now at the junction of Tex. 225 and Tex. 146. Here the motorist can go north to Baytown or south to La Porte, Seabrook, Texas City, and Galveston. In either case, the traveler will need to consult the index map for locations of the mineral related facilities in these areas.

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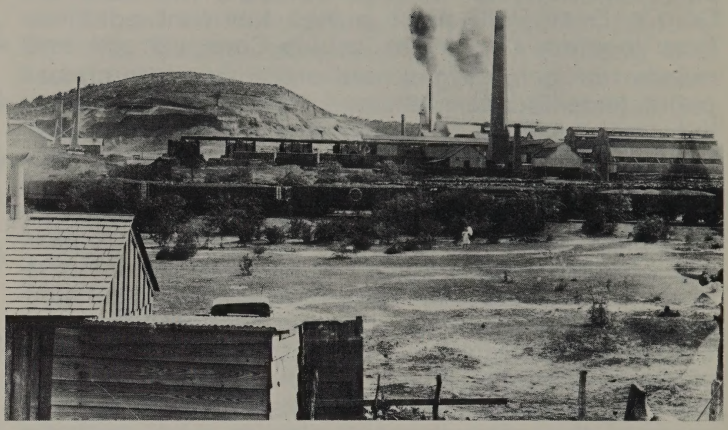
GHOST TOWNS AND MINING CAMPS

Interstate 20, Tex. 108.—The ghost town of Thurber is about 65 miles west of Forth Worth and 16 miles



Texas and Pacific Coal Co. brick plant in May 1901 at Thurber, Tex.

19 east of Ranger (map location 19). All that remains of this once-thriving town of about 10,000 are several company buildings, a large smokestack, and the foundation imprints of homes, businesses, and streets. Thurber was founded in 1888 by the Texas and Pacific Coal Co. and flourished as a coal mining and brick manufacturing town. Everything was owned by the company, and when a worker charged his purchases at the company's stores these bills were deducted before he received his pay. Consequently, a worker had little need for pocket money because his house rent, medical coverage, blacksmithing, transportation, and his union dues were also deducted or chargable. Thurber is believed to have been the first Texas city with 100 percent unionized industries. Electricity was installed in 1895, making the city one of the first in the world to have complete electrical service. Miners were recruited from throughout the world and some 20 nationalities were represented in the city's population. Italians and Poles formed the largest ethnic groups. Records show that immigrants from 16 countries became naturalized citizens while they were Thurber residents.

During the period from 1884 to World II, about 20 bituminous coal mines with romantic names such as "The Colonel," "The Old Girl," and "The Queen Bess" were in operation in the Thurber-Strawn area. The coalbeds mined at Thurber are in the Strawn Group (Pennsylvanian). Mining was by longwall method. Depth of the mine shafts ranged from less than 100 feet to over 400 feet at the Mount Marion mine in the southwest edge of Strawn.

The Texas bituminous coal industry reached its high-water mark during the World War I era when the average price of coal reached $6 per ton. By 1920, however, the value had plunged to less than $2.50 per ton. This precipitous decline reflects the rapid displacement of coal by oil from the State's growing petroleum industry. Although hundreds of millions of tons of minable coal remain, the Texas and Pacific Coal Co. closed its last mine in 1921. Employing the old adage "if you can't beat 'em join 'em," the company shifted its fuel operations to oil and gas and is currently doing business as the Texas and Pacific Oil Co. The brick plant closed in 1930, and the city was abandoned in 1933. Soon thereafter the company dismantled the town leaving only the mercantile store, the pharmacy, and the houses of the mine superintendent and company physician. Today two businesses operate in Thurber, the Smokestack restaurant, taking its name from the town's most prominent feature, and a service station with an observation platform (a replica of a tipple) built over it. From this platform a visitor can get a bird's-eye view of the old town-site and surrounding countryside. Historical markers are near the smokestack. Those large red mounds of earth that can be seen from Interstate 20 west of Thurber are coal mine dumps.

The bar in the company-owned saloon in Thurber, Tex. (Courtesy of T&P Oil Co.)

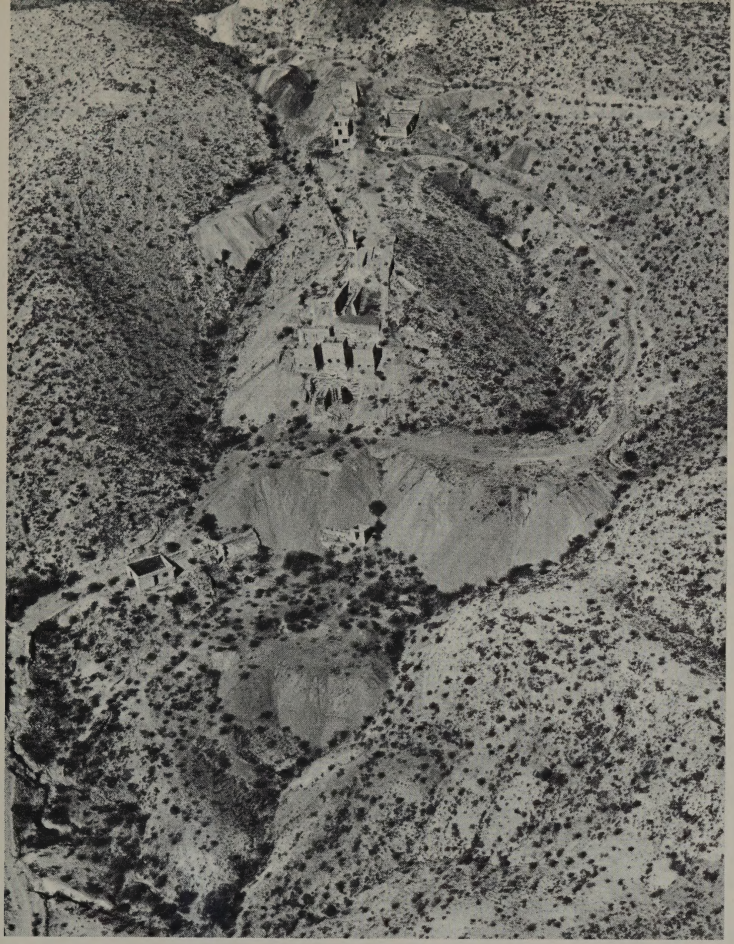
107

Big Bend National Park.—The Mariscal mercury mine and ghost mining camp is in the south-central part of the Big Bend National Park (map location 107). Cinnabar was discovered on the northern ridge of the Mariscal Mountain around the turn of the century. Soon thereafter, D. E. Lindsey began mining operations and produced some high-grade ore, which was transported by pack burro a distance of over 30 miles to the Terlinqua furnaces for refining. Lindsey recovered about 50 flasks of quicksilver before he closed his operation in 1906.

Cinnabar, the principal ore of mercury, is a red mineral composed of mercury sulfide (HgS). Mercury, or quicksilver, is recovered by utilizing this unique metal's characteristic of changing to a gaseous state at a temperature of about 675° F. The refining process consists of heating the cinnabar in a furnace to convert the mercury sulfide compound into sulfur dioxide and mercury gases. These vapors and combustion gases from the furnace fuel are cooled in the condensing units to allow the mercury vapor to condense into a liquid before the other gases are vented through the smokestack. Quicksilver is tapped from the bottom of the condensing tanks, cleaned of all soot, and packaged in 76-pound flasks.

The outbreak of World War I brought a sharp increase in the price of quicksilver. The price increase encouraged W. K. Ellis, who had acquired the Lindsey property, to reopen the mine. Ellis installed several iron pipe retorts to refine mercury from the cinnabar ore. Ruins of the concrete foundations for these retorts are at the base of the mountain. Near the end of the war a drop in mercury price occurred, which caused Ellis to sell the property to the Mariscal Mining Co.

Between 1919 and 1923, the Mariscal Mining Co. installed new facilities that included mechanical crushing equipment, ore storage bins, a 45-ton-per-day Scott furnace and condensing units. The Scott furnace was constructed of bricks that were handmade from local clay and fired in a kiln about 2 miles west of the mine. The condensing units were constructed up the slope and were interconnected with the furnace and smokestack by ceramic pipes. Crushed ore from the storage bins was hand-trammed in mine cars on elevated tracks for direct charging into the top of the furnace. Mesquite wood was used for fuel. The wood was supplied by Mexicans at about $5 a cord. Some of the wood was hauled to the mine on burros from distances upt to 50 miles. The Mariscal Mining Co. produced about 400 flasks of mercury during this post-war period before it ceased operation in 1923. During the next 17 years, the mine lay dormant, although efforts were made from time to time by var-

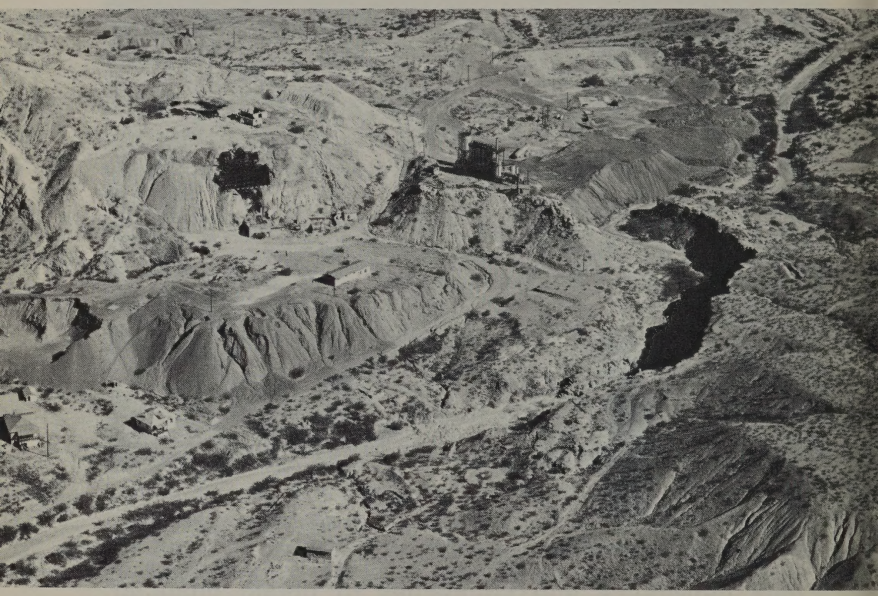


The approach road and ruins of the Mariscal mine perched on the side of Mariscal Mountains. The road ends at the roofless company warehouse. (Courtesy of General Land Office.)

ious individuals and companies to obtain financial backing to reopen the mine.

With the advent of World War II, mercury prices again shot upwards, and the Vivian Mining Co. was organized to reopen the Mariscal mine. The company installed a 30-ton-per-day-capacity Gould-type rotary furnace and built several new buildings including a new residence for the mine manager. Electricity for the mine was provided by a generator driven by an internal combustion engine. The company apparently spent most of its money on exploration and construction because it produced only 97 flasks of quicksilver during 1942 and 1943. Declining mercury prices and mounting financial difficulties resulted in bankruptcy of the company in 1944. The mining equipment and machinery was sold to the highest bidder and removed from the property. Soon thereafter, the National Park Service completed acquisition of the mineral rights to the Mariscal mine area thus ending any possibility of future mining at Mariscal.

Today as you approach the mine ruins, you will see the remains of the Scott furnace, condensing units, chimney, ore bins, and other masonry structures perched on the mountainside. Any portions of these structures that were constructed of wood have been destroyed by fire or removed by vandals. Broken pieces of the large vitrified clay pipe that connected the Scott furnace with the condensing units and chimney are strewn on the slopes below the condensers. During the last mining operation, some of the bricks from the Scott furnace were removed, crushed, and



Study Butte mercury mine and ghost camp. The remains of earlier mining activity is on the top of Study Butte. The last mining activity, ended in 1971, is directly in back of the condensing units in the center of the photograph. (Courtesy of General Land Office.)

retorted in a rotary furnace to obtain absorbed quicksilver. The waste dumps give evidence of the locations of the furnaces and, to some extent, the amount of ore processed during each period of operation. The main shaft, headframe, hoisting equipment, and blacksmith shop were located on a ledge near the crest of the mountain. The wooden headframe was destroyed by fire. Some of the hoisting equipment, wire rope, basket, and skip are jammed in the shaft about 30 feet below the collar. The remains of the blacksmith shop can be identified just north of the main shaft. The crumbling adobe walls of the mine manager's house and the crudely constructed rock huts of the Mexican miners are scattered along the lower slopes and flats at the base of the mountain.

Life at the Mariscal mine and camp was Spartan. The work was hard, the pay was low, and the environment was hostile. The normal workday in the 1940's was 10 hours or more per day, 6 days a week. Experienced miners received $1.50 per day, muckers $1.25 and common labor $1.00 per day. Water had to be hauled from wells in the Fresno creek area several miles from camp. There were no schools for the children. The miners had to build their huts from local stone, adobe, and sticks on their own time. While constructing their houses, they lived in the open, under brush arbors, or in dugouts in the side of the mountain.

Park rangers should be consulted before one visits the Mariscal mine because of the remote location and unpredictable road conditions. Care should be exercised because the mine shafts are unprotected. There are several open vertical shafts and adits (tunnels) that lead into the underground workings. The subsurface mine workings are at levels of about 30, 60, 75, 90, 100, 150, and 250 feet. Some of these levels are interconnected underground by raises and winzes. Mining was conducted in open stopes (unsupported rooms) and drifts (halls) where the miners "chased" calcite veins and breccia filled pipes that contained the cinnabar ore. Because of the durability of the limestone and igneous intrusive country rock, the underground workings remain stable although some stopes were first opened almost 70 years ago.

Tex. 118.—The ghost mining camp and Study (pronounced Stoody) Butte mine are 2 miles west of the entrance to the Big Bend National Park and 78 miles south of Alpine (map location 108). In 1902, quicksilver was discovered on a hill of intrusive igneous rock (quartz soda syenite) that is now known as Study Butte. Three years later, Will Study opened the Butte mine, and scores of rock and adobe huts were quickly thrown up to house the 100 or more workers and their families. The mine consists of 4 main shafts, several minor shafts, and more than 3 miles of horizontal workings. The deepest shaft is about 450 feet. The mine closed in 1944 but was reopened from 1969 until May 1971. All buildings and mining equipment installed during the last mining operation have been removed except a rotary furnace and condensing unit. A collapsed headframe and other relics of the early mining activities are on top of the butte. Abandoned company buildings and the remains of numerous rock and adobe houses of the original mining camp are on the east side of the butte. Again, caution should be exercised when visiting the area because some of the shafts are not protected.

108

FM 170.—The 248 quicksilver mine and abandoned mining camp are about 2 miles east of Terlingua

109 (map location 109). The mine shaft and headframe are within 50 feet of the highway. Abandoned in 1946, the property has been ransacked; no mining equipment and virtually no usable materials remain although one or two of the crumbling adobe dwellings are occupied from time to time. The underground mine consists of over 7,000 feet of horizontal workings at 13 levels to a depth of about 800 feet. The cinnabar ore was confined to an almost vertical breccia pipe. This cigar-shaped ore body ranges in diameter from 100 to about 300 feet. The mine and camp areas are closed to the public but can be viewed from the highway.

110 **Tex. 118, FM 170.**—The ghost town of Terlingua (map location 110) is in the heart of the Texas mercury district about 7 miles west of the entrance to the Big Bend National Park. Terlingua became a thriving town of 2,000 people after mercury was discovered on California Hill in the late 1890's. Millions of dollars worth of rich red cinnabar (the ore of mercury) was mined from beneath the barren hills of this harsh land before the ore was essentially exhausted.

The Chisos mine, located under and adjacent to the town, was the most productive mine in the Terlingua district. The mine was in almost continuous operation

Headframe of the 248 mercury mine on highway 170. In the background are the Chisos Mountains in the Big Bend National Park. Ocotillo cactus stands gracefully in the foreground. (Courtesy of Texas Highway Department.)

Ghost town of Terlingua, Tex. The mountain range seen in the background is the Chisos Mountains in the Big Bend National Park.

from 1900 until 1945 and produced over 100,000 flasks of quicksilver. A significant amount of this production came from a "pipe" ore body that has been called the richest single stope in the United States. The Chisos mine has numerous shafts and over 23 miles of underground workings at depths to 825 feet. All the headframes have collapsed or been removed except one that stands on the south rim of the hill west of the smokestack. Relics of the furnace operations are below the smokestack.

Fuel for the furnaces to refine the mercury was a continuing problem in the mercury district. Wood was the principal fuel during the early years, and the barren landscape around Terlingua gives stark evidence to the magnitude of this problem. In the early 1930's the Chisos Mining Co. opened a coal mine about 6 miles northeast of Terlingua in an attempt to solve the fuel problem. A subbituminous coal seam of about 4 feet was mined by the panel method. Production was probably less than 50 tons per day. The coal was converted into producers gas for use in the mercury furnaces and to a limited extent for household use.

To 1946, the Terlingua district had accounted for about one-fourth of the total U.S. mercury production. The company's general store, a church, and the mine owner's residence, which is often mistaken for a hotel, remain in various states of disrepair. Scores of rock and adobe huts stand, roofless, walls crumbling, that were once home to the miners and their families.

Although uninhabited, Terlingua springs to life for a few days each year in early November when thousands of contestants, hecklers, and spectators converge on the town for the Annual World's Chili Cookoff.

You may visit the town and cemetery but the underground mines are not open to the public. Caution should be exercised because the shafts and opencuts leading to the underground workings are generally unprotected and caving exists in local areas.

112 **U.S. 67.**—Shafter, population about 30, is 40 miles south of Marfa (map location 112). Shafter began as a silver mining camp and once had a population of 2,000 during its boom days. John Spencer is credited with discovering silver at Shafter in 1880 although diggings in the area indicate that the Spaniards may have prospected for silver and gold here centuries before. Spencer and General William R. Shafter, for whom the town was named, organized the Presidio Mining Co. and opened the silver mine in 1883.

The mine was subsequently developed through slope and vertical shafts at depths ranging from 400 to 900 feet. More than 50 miles of horizontal underground workings were excavated in mining the hundreds of millions of tons of limestone rock that contained silver, gold, and lead ores. The mine shafts were about a mile southwest of town, and mule-drawn wagons were used to haul the ore to the mill on Cibolo Creek in Shafter. In 1913, an aerial tramway was built to move the ore overhead to the mill. Gold and silver were recovered by passing the finely pulverized ore from the stamp mill over a surface of liquid mercury to form an alloy or amalgam containing mercury, gold, and silver. (Amalgams of silver or gold are used by dentists to fill cavities in teeth.) Gold and silver was then extracted by fire refining. The amalgamation recovery method was later replaced with a more efficient cyanidation process. Cyanidation extraction consists of leaching the powdered ore in a dilute solution of potassium or sodium cyanide. The dissolved metals are then precipitated in the form of finely divided particles. These particles are then fused and cast into bullion. The large metal tanks used in the cyanide leaching process are still in the ruins of the mill.

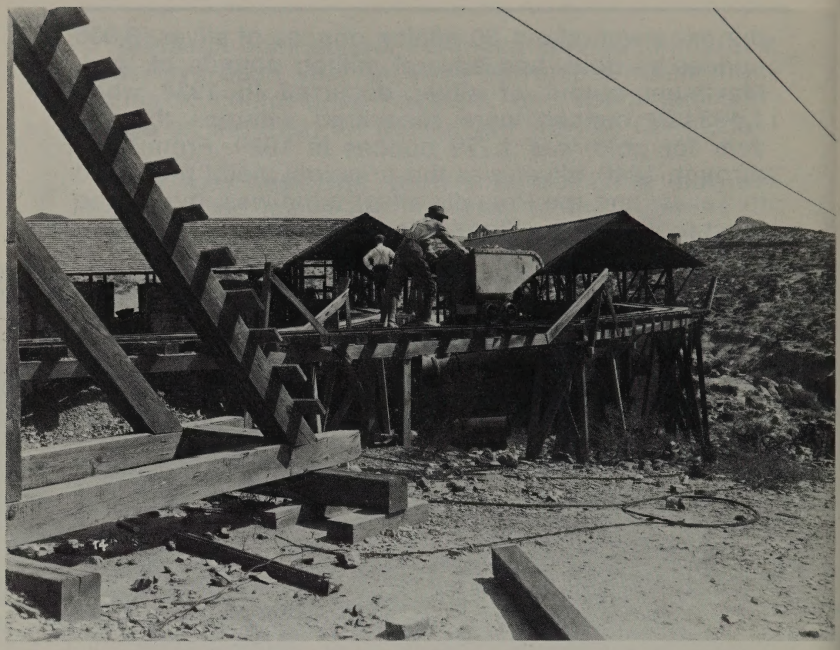
In September 1942, the mine was closed after over 50 years of almost continuous operation. The American Metal Co. of Texas, which purchased the operation in the 1930's, was the last operator. During the last 9 months of operation, the company recovered over 0.5 million ounces of silver and about 200 ounces of gold. Cumulative production for the Presi-

dio mine was about 30 million ounces of silver, 8,000 ounces of gold, and several million pounds of lead. Maximum output of silver occurred in 1938 when 1,433,000 ounces were recovered whereas the top year for gold was 1,279 ounces in 1929. From 1883 through 1942, silver was the principal metal produced in Texas, and the Presidio silver mine was, by far, the most prolific of the State's silver mines.

Ruins of silver mill at Shafter, Tex. (Courtesy of Texas Highway Department.)

In the end, the Presidio mine fell victim to the same malady to which all mines eventually succumb; that is, declining ore grade and rising production costs. Other contributing factors were declining silver prices and labor problems. Although the Presidio mine and mill were closed in 1942, individuals and small companies continued to mine ore in the Shafter silver district until 1954. These ores were shipped to the El Paso smelter for refining.

The mining area is posted and is off limits to the public. However, there are no restrictions on touring the town and adjacent mill ruins.



Cinnabar ore is handtrammed to the furnace at the Waldron mine circa 1916. The furnace and condensing units can be seen in the background ,under the roof of the building. (Courtesy of the Smithers Collection, Humanities Research Center, University of Texas at Austin.)

MINES YOU CAN VISIT

111 **FM 170.**—The inactive Waldron or Colquitt-Tigner mercury mine (map location 111) is 2 miles west of Terlingua and about a mile north of FM 170 on a local road. Mining operations began in 1925 and ended in the mid-1930's. The underground workings consist of about 900 feet of drifts on the main level, which is entered by an adit (tunnel) in the hillside close to the old furnace ruins and is connected to the surface on top of the hill by shafts and open cuts. Mercury ore was recovered at intervals (stopes) along the adit and in solution caverns in the northwest part of the main level. The interconnected caves in the northwest part of the mine workings are some of the largest solution cavities in the Terlingua district. The caves have a combined length of over 330 feet, a maximum width of about 60 feet and extend to a depth of about 200 feet. Some of the solution caves originally contained sulfide and chlorides of quicksilver in quantities that were mined as ore. Calcite is the most common fissure and joint filling mineral. Some traces of cinnabar can be seen in the mine. Visitors may tour the mine and search for cinnabar and other mineral specimens at the mine dump. An admission fee is charged.

ROCK COLLECTIONS AND MUSEUMS

The University of Texas at Austin has mineral, rock, and fossil collections on display in the Geology Building and at the Texas Memorial Museum on San Jacinto Street on the campus.

The University of Texas at Austin has mineral, rock, and fossil collections on display in the Geology Building and in the Centennial Museum on the campus.

Mineral, rock, and fossil collections are on display at the Texas Museum of Natural History at Second Avenue and Grand Avenue at Dallas Fair Park.

FOR MORE INFORMATION WRITE OR VISIT

Bureau of Economic Geology, University of Texas, Box X, University Station, Austin, Tex. 78712.

Federal Bureau of Mines Liaison Office, Room 782, Federal Building, Austin, Tex. 78701.

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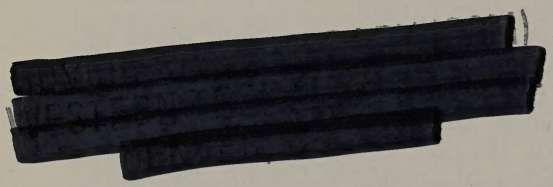

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